SPACELABS Healthcare

# Ultraview SL™ Operations Manual

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⚠ **Before use, carefully read the instructions, including all warnings and cautions.**

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# Introduction

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## Overview

Spacelabs Healthcare monitors provide clinical information, when and where you need it, using a complete range of patient monitoring functions. They also are flexible enough to be set for any level of acuity, and they can be precisely and easily adjusted, using touchscreen technology. Some products also provide charting at the bedside and the ability to interact with alarms and information from other devices.

Spacelabs Healthcare networking features support seamless data acquisition and data exchange across the medical enterprise, addressing the need for continuous information management. These powerful tools enhance patient safety and help you care for patients more efficiently by providing access to, and remote control over, patient data.

## Indications for Use

Spacelabs Healthcare patient monitors, functioning as either bedside or central monitors; passively display data generated by Spacelabs Healthcare parameter modules, Flexport interfaces, and other SDLC based products in the form of waveform and numeric displays, trends and alarms. Key monitored parameters available on the model 91367, 91369, 91370, and 91387, when employing the Spacelabs Command Module, consist of ECG, respiration, invasive and noninvasive blood pressure, $SpO_2$, temperature and cardiac output. Additional parameters and interfaces to other systems are also available depending on the parameter modules employed.

Spacelabs Healthcare patient monitors are intended to alert the user to alarm conditions that are reported by Spacelabs Healthcare parameter modules and/or other physiologic monitors via Flexport interfaces. These devices determine a) when an alarm condition is violated; b) the alarm priority (i.e. high, medium or low); c) alarm limits; and d) when to initiate and terminate alarm notifications. The patient monitors are also capable of displaying alarm conditions on other monitors that are on the network through the Alarm Watch feature.

Spacelabs Healthcare patient monitors may also function as a generic display or computer terminal. As a generic display or terminal, the patient monitors allow network-based applications to open windows and display information from other networked devices.

Spacelabs Healthcare patient monitors are also designed to communicate with a variety of external devices such as displays, network devices, serial devices, user input devices, audio systems, and local/remote recorders.

Spacelabs Healthcare patient monitors are intended for use under the direct supervision of a licensed healthcare practitioner, or by personnel trained in proper use of the equipment in a hospital environment.

**Following the *Introduction* chapter, this Operations Manual is organized as follows:**

- Chapter 2, *Glossary of Terms*, provides concise descriptions of features and terms used in this manual.
- Chapters 3, 4, 5, and 6 describe the bedside and central monitor features.
- Chapters 7, 8, and 9 provide detailed information about admitting and discharging patients, setting up alarm configurations, and printing.
- Chapters 10 through 29 are individual clinical parameter chapters. These chapters contain clinical overviews, diagrams of the touchscreen keys and menus specific to that particular function or parameter, descriptions of the monitor screens, operating instructions, status/error messages, troubleshooting suggestions, and other relevant information.
- Chapters 30 through 34 contain information about product and equipment specifications, cleaning and maintenance, batteries, diagnostic messages, and symbols related to Spacelabs Healthcare products.

Your system configuration, including the options ordered, may be different from the configurations described in this manual. Refer to the notes in this manual describing the features affected by system configuration.

***Warning:***

- ***Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors that exhibit obvious damage.***
- ***If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.***
- ***Because of the potential for electromagnetic interference, electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) should not be operated within 3.5 feet (1.07 meters) of the patient, patient leads, or associated monitoring equipment until the devices can be evaluated by the biomedical engineering staff.***
- ***Failure to properly configure this device prior to network connection may alter network time, or corrupt patient data.***

# Quickstarts

This manual includes “Quickstarts,” which include steps for explaining how to access and use the various features and parameters of the Spacelabs Healthcare monitors. If specific products require separate steps, the steps are listed in two columns. For example, the following Quickstart refers to the bedside and the central monitors. Refer to *Figure 1-1*.

**This is a Quickstart:**

| Bedside Monitor | Central Monitor |
|---|---|
| • If an action **only** applies to the bedside monitors, it will appear on the left side of the Quickstart. | • If an action **only** applies to the central monitor, it will appear on the right side of the Quickstart. |
| • If an action applies to all monitors, it will appear in the center of the Quickstart. | |
| • This action only applies to bedside monitors. | • This action only applies to central monitors. |

*Figure 1-1: Quickstart*

# System Components

**Spacelabs Healthcare monitoring products include:**

- Bedside monitors
- Central monitors
- Parameter modules
- Module housings
- Printers
- Flexport® system interfaces
- Telemetry



SL Command Module



SL2700 bedside monitor (and display)



SL2700 bedside monitor (neonatal configuration)



SL2800 bedside monitor (and display)



SL2900 bedside monitor (and displays)



SL2200 bedside monitor or portable monitor



SL2400 bedside monitor or portable monitor



SL2600 bedside monitor or portable monitor

*Figure 1-2: Spacelabs Healthcare system components*

## SL2200 Monitor

The SL2200 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2200 includes an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports networking. An optional printer and optional wireless networking capabilities are available. Refer to the *Ultraview SL2200 (91367) OperationsManual*, P/N 070-1332-xx, for more information.

## SL2400 Monitor

The SL2400 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2400 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.

## SL2600 Monitor

The SL2600 is a mid-range, compact monitor with a 12.1-inch touchscreen display. It is designed for bedside and portable use. The SL2600 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.

## SL2700, SL2800, and SL2900 Monitors

The SL2700, SL2800, and SL2900 are bedside monitors that accommodate two single-high parameter modules using external displays. Included with each monitor is a DC power supply that provides power for the monitor and up to three Flexport interfaces. The SL2700 and SL2800 are single-display configurations; the SL2900 is a dual-display configuration. Refer to *Flexport System Interface* on page 1-9 for information on Flexport interfaces.

## SL3800 and SL3900 Monitors

The SL3800 and SL3900 central monitors display patient-specific parameters, remote alarms, and alarm limits based on the settings of the bedside monitor, as determined by the primary caregiver. The SL3800 is a single-display configuration; the SL3900 is a dual-display configuration. Refer to *Central Monitors* on page 4-5 for detailed information on the capabilities of these monitors.

## Parameter Modules

Parameter modules are used with a Spacelabs Healthcare monitor to monitor clinical parameters such as electrocardiography (ECG), noninvasive blood pressure (NIBP), pulse oximetry ($SpO_2$), electroencephalography (EEG), Bispectral Index (BIS), and capnography. Each module is shipped with default settings for alarms and various other operational settings, which can be adjusted to meet the needs of your patients or comply with your hospital's protocol.

Some parameter modules can also be used to transfer all of a patient's data from one monitor to another monitor. This is accomplished using the Data Shuttle® option. Refer to *Data Shuttle Option* on page 3-16 for more information.

### Installing Parameter Modules

Modules can be inserted directly into the monitor, as shown in *Figure 1-3* on page 1-7, or into a module housing. Refer to *90491 and 90499 Module Housings* on page 1-7 and *91493 Integrated Module Housing* on page 1-8 for additional information.

**To install a module:**

- Ensure that the locking lever on the module is closed and that the module is oriented correctly.
- Insert the module into any open slot in the monitor or module housing.
- Slide the module into the monitor or module housing until the front of the module is flush with the front of the monitor. A light "click" indicates that the module is locked in place.

**If the front of the module is not flush with the front of the monitor or module housing, DO NOT FORCE THE MODULE.**

- Remove the module and clear the obstruction before trying to insert the module again.
- If there is no obstruction, check the orientation of the module, then repeat the installation steps.



*Figure 1-3: Module insertion*

**To remove a module:**

- Disconnect any cable(s) from the front of the module, if necessary.
- Push the left side of the locking lever.
- Hook your finger through the open locking lever, then pull the module out of the slot.

## 90491 and 90499 Module Housings

The 90491 and the 90499 module housings are lightweight, standalone units that expand the capabilities of a Spacelabs Healthcare monitor, enabling the monitor to support additional parameter modules. Parameter modules can be inserted into or removed from a module housing without disconnecting the power. Module housing also provide flexible mounting and cabling options.

Both the 90491 and the 90499 module housings require a separate external power supply.

- The **90491 module housing** accommodates four single-high modules or one double-high printer module and two single-high modules.
- The **90499 module housing** accommodates two single-high modules or one double-high printer module.

### 90491 and 90499 Module Housings — Power Failure

***Warning:***

- ***In case of a power failure, the module housing (90491 or 90499) provides +5 V of power to maintain data integrity for up to three minutes.***
- ***If the power is interrupted to the module housing but not to the monitor, the module remains active and the following occurs:***
  - ***Waveforms go flat (as if the patient has no vital signs) or completely disappear.***
  - ***Parameter values default to the minimum limit or are displayed as question marks (???), (except for noninvasive pressure, which displays the last value obtained before the power failure).***

- ***Alarms may sound for low limit violations or for conditions such as Asystole (ECG), Leads Off (ECG), Loss of Signal (Respiration), or Adapter Disconnected ($SpO_2$).***
- ***Cardiac output displays Catheter Fault and Probe Fault.***

- ***If any of the above conditions occur, check to determine whether or not AC power has been interrupted to the module housing, and reestablish it, if necessary.***

## 91493 Integrated Module Housing

The 91493 Integrated Module Housing expands the configurability of the SL2400/SL2600 compact monitors from one to three modules by providing two additional module slots. The Integrated Module Housing directly attaches to the base of the monitor.

Parameter modules can be inserted into or removed from a module housing without disconnecting the power.

The Integrated Module Housing is powered from the monitor, and does not use a separate power supply or cables.




*Figure 1-4: 91493 Integrated Module Housing shown with SL2600 monitor*

***Note:***

- *Modules inserted into the Integrated Module Housing must be aligned in the correct horizontal orientation. Refer to Figure 1-4.*
- *The module label text should be readable when the module is inserted properly.*

## Printers

Patient information in the form of numerical data and waveforms can be printed using the 90449 printer module, the 90469 system printer module, or an ICS printer. An integrated printer is also available in the SL2400/SL2600 monitors.

The 90449 printer module is an external printer that prints one- or two-channel waveform recordings on 50-mm heat-sensitive paper. It can store up to three waveforms and annotation values, and is only used as a bedside printer.

The 90469 system printer module is an external printer that prints one-, two-, or four-channel waveform recordings on 50-mm and 120-mm heat-sensitive paper. It can store up to 12 waveforms and annotation values. Four-channel waveform recordings are only available when the four-channel paper tray is used. The 90469 system printer module may be used as a bedside printer or as a central printer.

The SL2400/SL2600 integrated printer is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm roll paper. The printer prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data.

## Flexport System Interface

The Flexport system interfaces integrate data from compatible third-party peripheral devices (such as ventilators, multigas analyzers, pulse oximeters, NIBP monitors, intravenous (IV) pumps, incubators, and capnographs) into Spacelabs Healthcare monitors. Refer to *External Flexport System Interface Connection* on page 3-23 for additional information.

Flexport interfaces provide current numeric data, alarm information, and selected waveforms. All the data communicated to the Spacelabs Healthcare monitor is available at network locations, providing alarms and centralized displays. Contact your Spacelabs Healthcare Sales Representative for additional information.

# System Basics

## Default Settings

Modules are shipped with factory defaults for alarms and other parameter settings (for example, NIBP reading frequency), which can be adjusted to meet the needs of your patients. When events occur that might cause the selected limits or values to return to the default settings, the monitor may display a CHECK SETUP key in the ECG zone, combined with a low-priority alarm tone (refer to *Setting Alarm Limits on page 7-7* for details on alarm priorities). To cancel the message and the alarm, touch the CHECK SETUP key on the display. Refer to *Check Setup* on page 3-6 for additional information.

## Patient Preparation

To prepare a patient for monitoring, attach the lead wires and sensors to the patient and connect the sensors cable to the module. Touch a parameter key, then touch menu keys as needed to set up monitoring for a specific parameter. Refer to the parameter chapters for additional information on patient preparation.

***Note:***

*Use only Spacelabs Healthcare parts and accessories with your Spacelabs Healthcare products. Other parts and accessories may degrade performance or damage the components. Refer to the Spacelabs Healthcare Supplies Products Catalog for the part numbers and descriptions of additional parts and accessories.*

## Touchscreen Keys

Spacelabs Healthcare monitors use touchscreen keys to execute monitoring functions (refer to *Figure 1-5*). These keys are:

1. Parameter keys
2. Monitor keys
3. Menu keys

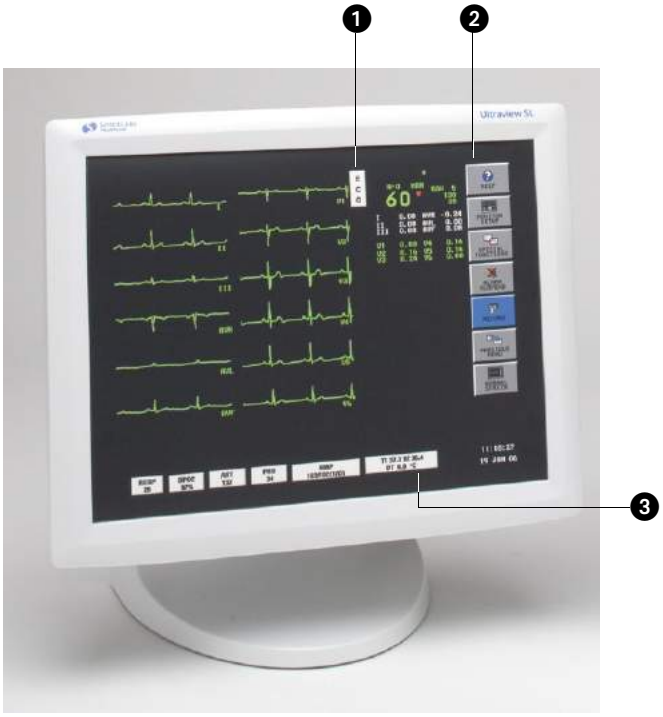



*Figure 1-5: Touchscreen keys*

## Monitor Keys

Monitor keys are located in a vertical row along the right side of the monitor's display. They are always visible and perform specific functions regardless of the parameter being monitored.




**HELP** — Touch the HELP key and then the touchscreen key if you have questions about a key. A description of that key's function appears. Touching the HELP key twice displays system information (model and software version) and configuration data.




**MONITOR SETUP** — Touch this key to remotely enter patient demographic data, modify the display format, adjust brightness, adjust tones, and specify printing settings.




**SPECIAL FUNCTIONS** — Touch this key to remotely view other bedside monitors, to activate automatic notification of remote alarms, to view trends, to view clinical and drug calculations, and to use other optional network applications, such as WinDNA.




**TONE RESET/ALARM SUSPEND** — Touch this key once during an alarm condition to silence the alarms for 45 seconds at that monitor (bedside or central). Touch the key again during the initial 45-second suspension to silence the alarms for three minutes at the bedside monitor only. Refer to *Alarms* on page 7-5 for more details.




**RECORD** — Touch this key to print monitored data using a bedside printer, system printer, or printer module. Touch this key and then touch a flashing parameter key to print parameter data. Refer to *Printing* on page 9-5.




**PREVIOUS MENU** — Touch this key to move backward through prior menu levels one at a time. From the **Main** Menu level, this key removes the menu or window from the display.




**NORMAL SCREEN** — Touch this key to close any active window and its menus and return the monitor to its basic display.

## Parameter Keys

Touching the parameter key to the right of the waveform zone displays menu keys at the bottom of the display that are specific to that parameter.

## Menu Keys

The menu keys appear along the bottom of the monitor's display. They display controls for specific parameters and the monitor keys.

Menu keys that are active appear in a contrasting color. Inactive keys appear dithered or in dim lettering. If you touch an inactive menu key, an error tone sounds.

## Using a Keyboard and Mouse

Monitors support standard USB keyboards and mice as optional control devices.

An on-screen keyboard is provided for certain applications, such as Admit/Discharge, but you can also use an external keyboard. Refer to *Changing or Entering New Patient Data on page 8-3* for a description of the on-screen keyboard.

If your system is equipped with a mouse, it can be used for selected functions in place of the keyboard or the touchscreen. To use the mouse, position the cursor on a key and click the left mouse button to activate that key.

## Remote Control Keypad (90360)

The optional 90360 remote control keypad is a cordless, hand-held transmitter powered by an internal battery. It transmits instructions needed to operate a monitor via infrared signals to the monitor's receiver. Using the remote control keypad, you can remotely suspend or adjust alarms, access trends, adjust waveform size, and print. The zoom function enlarges menu keys on the monitor, making them easy to read from across the room. The maximum operating range is 6 meters (20 feet) at an angle of up to 45 degrees on either side of the receiver. A single 90360 can be used to control several monitors if each is equipped with an infrared receiver. Refer to *Remote Keypad* on page 29-3 for additional information.

# Network Basics

Networking enables you to communicate between beds in a single care unit or to review information from another care unit by specifying the unit as well as the bed. Each care unit is designated as a subnet on your networked system. This identification appears on the subnet keys in the bed selection menus.

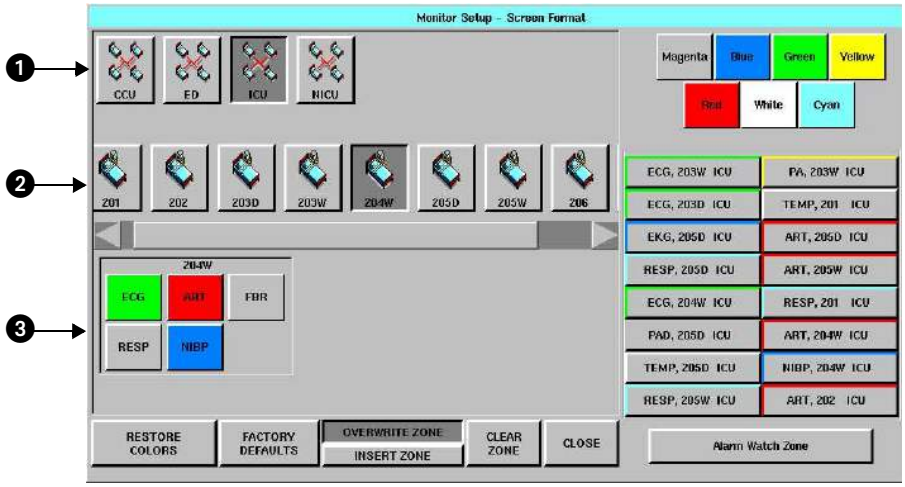



*Figure 1-6: Screen Format menu, split-display central monitor*

1. Subnet keys
2. Bed keys
3. Parameter keys

When you view clinical parameter information for a particular bed from another bedside monitor, or from a central monitor, you can control those parameters just as if you were at that remote bedside.

**Some of the available features are:**

- ***Standard*** networking, which allows the remote viewing of parameter data from bedside to bedside, and from bedside to central monitor (refer to *Viewing Remote Parameters* on page 1-14).
- ***Advanced*** networking, which allows remote access and interaction with clinical and drug calculations and tabular and graphic trends(refer to *Reviewing Remote Trends* on page 1-16).
- ***Full Bed Review***, which allows remote viewing of the entire bedside monitor information (refer to *Full Bed Review* on page 1-17).

The Spacelabs Healthcare network is configured according to your hospital's specifications. Typically, hospitals designate a system administrator for this task.

*Figure 1-7* illustrates a possible Spacelabs Healthcare network configuration.

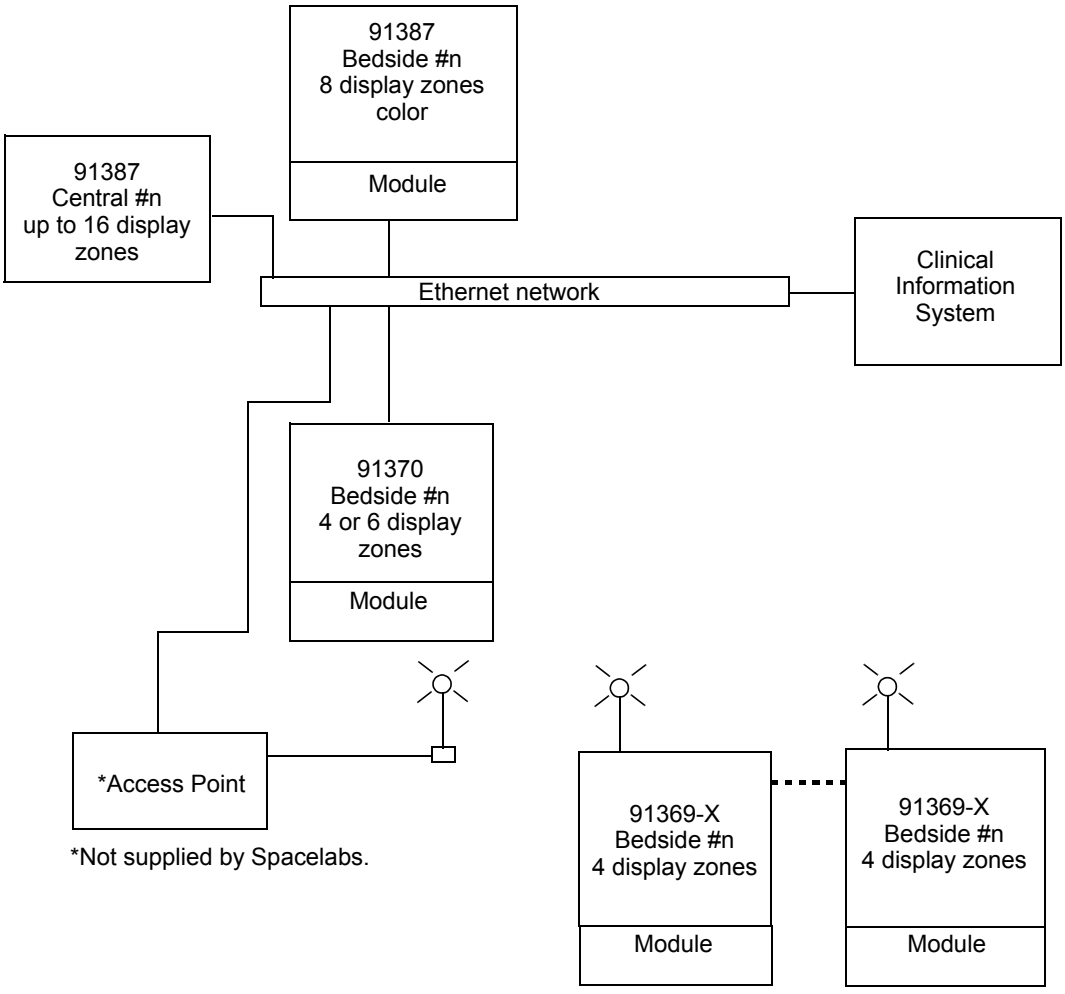



*Figure 1-7: Example of a network configuration*

# Alarm Watch

With the network Alarm Watch feature, you can be notified at a local bedside or the central monitor of all alarms from a remote bed (refer to *Alarm Watch* on page 7-12 for additional information).

# Viewing Remote Parameters

The Remote View feature enables you to view data from any bedside monitor at any other bedside or the central monitor. Remote views of waveforms and numerics are nearly identical in appearance and function to those of the parameter at the originating monitor. Each patient's data appears in a zone that is separated from other zones by a dividing line. Menu keys, alarms, and recordings are also accessible. Arrhythmia and ST segment data can be viewed from remote monitors if optional arrhythmia and ST segment analysis software is part of your system. Parameters from bedside monitors can be remotely viewed by up to 16 other monitors.

**To view remote parameters:**

| Bedside Monitor | Central Monitor |
|---|---|
| • Touch SPECIAL FUNCTIONS.<br>• Touch REMOTE VIEW. | • Touch MONITOR SETUP.<br>• Touch SCREEN FORMAT. |
| • Select a bed, or select a subnet and then select a bed.<br>• Select a parameter key. | |
| | • Select the destination waveform zone.<br>• Select a parameter and a color. |

Remotely viewed parameters occupy the lowest zone on the bedside monitor display. When a bedside monitor is set up to remotely view a parameter from another bedside, a one-second advisory tone sounds at the onset of an alarm condition (if the remote alarm tone is enabled).

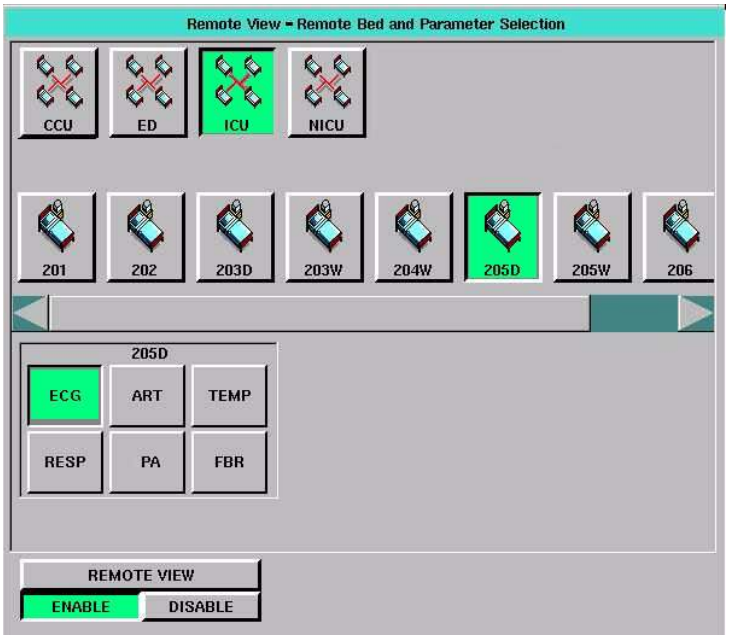



*Figure 1-8: Bedside monitor, Remote View bed and parameter selection*

On the central monitor, a specific zone is assigned to each remote parameter. Central monitors sound alarm tones in the same manner as bedside monitors.

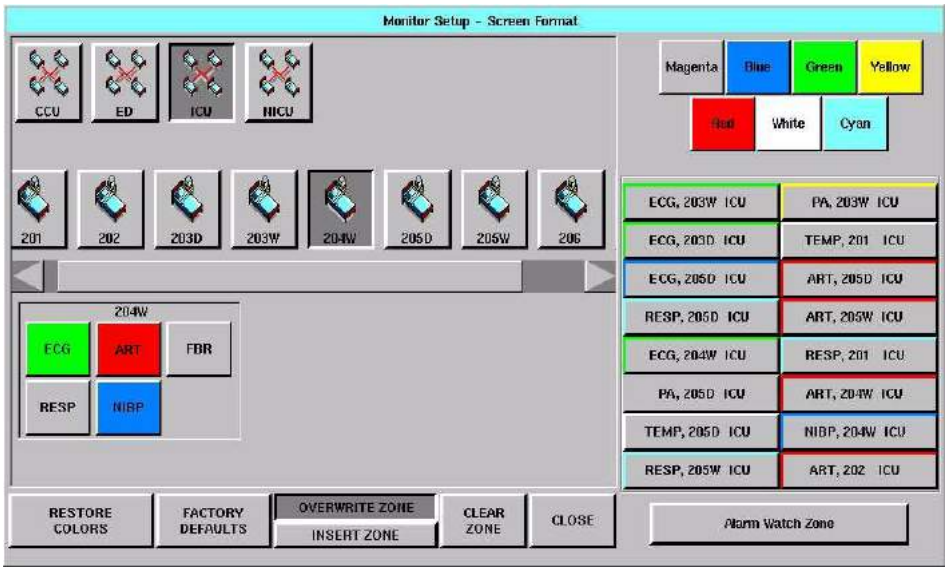



*Figure 1-9: Central monitor, Screen Format bed and parameter selection*

The central monitor also features an optional communications interruption feature. Keys will appear in the waveform zone of the interrupted channel to permit disabling of the alarm tone associated with the interruption, and to remove the zone from the display. Refer to *Data Communications Watch* on page 4-8 for more information.

# Reviewing Remote Trends

Vital signs trending provides minute-by-minute logging of parameter data for review and documentation in the patient record. Retrospective vital sign review through either graphic or tabular trends provides minute-by-minute access to data from any monitor on the network. You can select the format and interval for trending. Refer to *Trends* on page 28-3.

**To display a trend from a remote monitor:**

- Touch SPECIAL FUNCTIONS.
- Touch REMOTE TRENDS/CALCS.
- Select a bed, or select a subnet and then select a bed.
- Touch GRAPHIC TRENDS or TABULAR TRENDS.

# Full Bed Review

The optional Full Bed Review (FBR) feature (available with the SL2600/SL2700/SL2800/SL2900/SL3800/SL3900 monitors only) enables you to simultaneously view multiple parameters from a remote monitor at your bedside or central monitor. If no menus appear when a bedside or central monitor is displaying another monitor's data, an FBR key appears in the lower left corner. Selecting this key activates the FBR feature.

The monitor where FBR is enabled displays, within its capabilities, all available parameters from the remote monitor. If more parameters are available from the remote bedside than FBR can display, keys for these additional parameters are displayed as numeric keys along the bottom of the display. Selecting any of these numeric keys causes the selected parameter to replace the lowest parameter on the display.

**To activate Full Bed Review (FBR) when a remote parameter is displayed:**

| Bedside Monitor | Central Monitor |
|---|---|
| • Touch NORMAL SCREEN to display all parameters.<br>• Touch FBR. | • Touch NORMAL SCREEN to display all parameters.<br>• Touch FBR.<br>• Touch the flashing parameter key for the remote bed. |

**To activate Full Bed Review (FBR) when a remote parameter is not displayed:**

| Bedside Monitor | Central Monitor |
|---|---|
| • Select a bed, or select a subnet and then select a bed.<br>• Touch the FBR key displayed after the last parameter key.<br>• -OR-<br>• To activate FBR as described above, select a parameter key. | • Select a waveform zone where you want to assign the parameter. |

**To deactivate Full Bed Review (FBR):**

- Touch NORMAL SCREEN.

The parameter keys displayed by the FBR function are interactive. To access the controls for a parameter, touch that parameter's key. Remote review of trended or calculated data for the selected monitor is available by touching the REMOTE TRENDS/CALCS key in the **Special Functions** menu.

***Note:***

*Full Bed Review displays a single ECG lead if the remote bedside is configured to display ECG data using the full-view format or split-view format.*

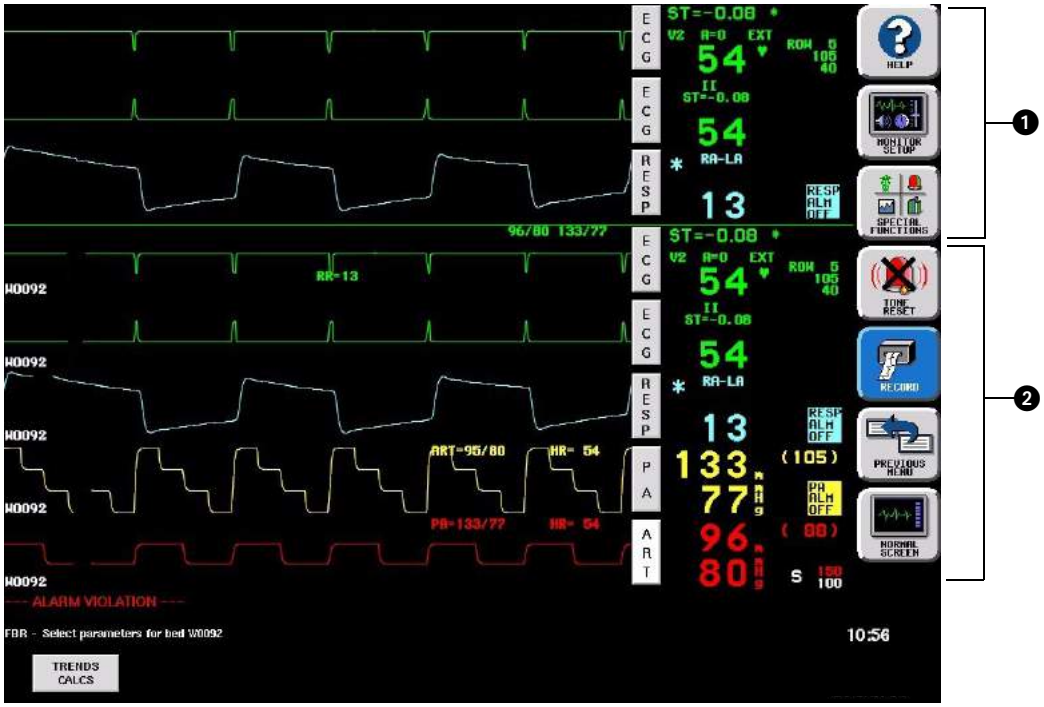



*Figure 1-10: Full Bed Review*

1. Local bedside view
2. Remote bedside view

# Glossary of Terms

This summary provides definitions of terms related to the Ultraview SL™ products.

| | |
|---|---|
| **12-Lead diagnostics** (page 13-3) | Conventional ECG signatures that accurately represent both the detailed waveforms in each cardiac cycle and their beat-to-beat variability. |
| **90449 bedside printer module** (page 9-9) | A two-channel printer that provides automatic and manual recordings of parameter data on 50 mm Z-fold paper. |
| **90469 system printer module** (page 9-11) | A two- or four-channel printer that provides automatic and manual recordings of parameter data on 50 mm or 120 mm Z-fold paper. |
| **90491 module housing** (page 1-7) | Accommodates four single-high modules or one double-height printer module and two single height modules. |
| **90499 module housing** (page 1-7) | Accommodates two single-high modules or one double-height printer module. |
| **90838 PrintMaster** (page 9-14) | A four-channel, network printer that provides automatic and manual recordings of parameter data on 8.5-inch × 11-inch or A4-size paper. |
| **91517 Capnography module** (page 23-5) | A mainstream and sidestream gas analyzer designed to measure the concentration of carbon dioxide in a gas mixture. Aids in determining the patient's ventilatory, circulatory, and metabolic status. |
| **91493 Integrated Module Housing** (page 1-8) | The 91493 Integrated Module Housing (IMH) expands the configurability of the SL2400/SL2600 portable monitors from one to three modules by providing two additional module slots. For bedside or transport use, the IMH attaches directly to the base of the portable monitors and does not require a separate power supply or cables. |
| **Admit/discharge** (page 8-3) | Enter new patient data, change data for an existing patient, and delete patient data if the patient is discharged. |
| **Advanced networking** (page 1-16) | Access and interact with clinical and drug calculations and tabular and graphic trends on remote monitors. |
| **Alarm attributes** | Alarm attributes (such as tone type, alarm recording, and alarm watch) can be independently configured for all parameters via the Module Configuration Manager. For more information, refer to the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx). |
| **Alarm Limit Review** (page 7-16) | Provides a snapshot view of bedside alarm limits for all active parameters (only available with specific Ultraview SL modules). |
| **Alarm recording** (page 7-15) | A strip recording initiated upon an alarm. |
| **ALARM SUSPEND key** (page 7-11) | (Also refer to TONE RESET.) Bedside monitor feature that suspends all alarms and alarm recordings for three minutes. |

# Glossary of Terms

| | |
|---|---|
| **Alarm Tone Manager** (page 7-14) | A feature used by a system administrator to prevent alarm tones from being permanently disabled. |
| **Alarm Watch** (page 7-12) | Notifies you of alarms from a remote bed. |
| **Arrhythmia** (page 11-3) | Referring to the monitor's ECG detection and classification capabilities. |
| **Arrhythmia trends** (page 11-12) | Detailed trend presentation of Multiview™ II arrhythmia data. |
| **Arrhythmia review** (page 11-9) | The event and class review feature associated with the Multiview II arrhythmia algorithm. |
| **ART** (page 20-3) | Arterial Pressure. The first factory-default invasive pressure channel label. |
| **Battery backup** | A feature that preserves patient data during brief losses of mains power. |
| **Bispectral Index (BIS)** (page 26-3) | A mathematical value between 0 and 100 derived from the frequency, power, and phase throughout the entire frequency range of the EEG. |
| **Calculations** (page 27-5) | Hemodynamic, respiration, oxygenation, and renal calculations that use input values entered manually, or collected automatically by the system, to produce a set of output values. |
| **Capnography** (page 23-5) | A highly accurate method of measuring respiratory gas values. |
| **Cardiac output** (page 21-3) | Evaluates the patient's fluid status and the heart's pumping ability. |
| **Central Alarm Watch Manager** (page 7-14) | A feature used by a system administrator to allow alarm notification from a remote bed. |
| **Clinical calculations** | Refer to *Calculations*. |
| **Clock (system)** (page 3-12) | A clock can be continually displayed in the lower right corner of the display. |
| **Command module** (page 1-5) | Multiparameter module consisting of eight different parameter configurations of multi-lead ECG, noninvasive blood pressure (adult and neonatal), invasive pressure, pulse oximetry, cardiac output, and temperature combined into a single module. |
| **CPP** (page 20-7) | Cerebral perfusion pressure. An invasive pressure label. |
| **Data Communications Watch** (page 4-8) | The central monitor notifies you when its communication link with a bedside monitor is interrupted. |

| | |
|---|---|
| **Data Shuttle** (page 3-16) | Transfers up to 24 hours of trend and episodic data, plus patient demographic data (e.g., age, gender, name, and BSA), from one monitor to another. |
| **Default settings** | Modules are shipped with factory-default settings for alarms and other parameter settings. User-defined settings can be configured using the Module Configuration Manager. |
| **Density Spectral Array (DSA)** | An EEG display format. |
| **Diagnostic messages** (page 34-1) | A chapter in this manual listing messages that may appear on the display. |
| **Digital telemetry** (page 18-3) | Provides continuous monitoring of electrocardiographic signals in order to detect abnormal cardiac rhythms, including asystole, ventricular fibrillation, and ventricular tachycardia. |
| **Directory of keys** | Diagrams of touchscreen keys and menus at the beginning of each chapter. |
| **DNA (Dynamic Network Access)** (page 3-7) | Enables you to view and control a remote application. |
| **Drug Dosage calculations** (page 27-19) | Enables you to determine infusion rates for drugs based on drug concentration, desired dose, patient weight, and patient type (adult or neonate). |
| **Dynamic Network Access** | Refer to *DNA*. |
| **Electrocardiograph (ECG)** (page 10-5) | A method of continuously monitoring electrocardiographic signals. |
| **Electroencephalograph (EEG)** | A method of acquiring, processing, and displaying two- or four-channel EEG data and one channel of EMG (electromyogram) data. |
| **Enhanced vital signs** | Displays $SpO_2$, respiration rate, and noninvasive pressure in the ECG zone on central or remote bedside monitors. |
| **Event** (page 15-6) | A change in a patient's condition based on multiple variables. |
| **Event marks** | Indications at the top of any $SvO_2$ or EEG trend graph to note the point when an event occurs. |
| **FBR** | Refer to frequency band ratio. |
| **FBR** | Refer to Full Bed Review. |
| **Flexport system interface** (page 1-9) | Integrates data from compatible peripheral devices (such as ventilators, multigas analyzers, incubators, and capnographs) into Spacelabs Healthcare monitors. |

| | |
|---|---|
| **Frequency band ratio (FBR)** | A measurement of the ratio of total power in two EEG frequency bands. |
| **Full Bed Review (FBR)** (page 1-17) | Enables you to simultaneously view multiple parameters from a remote monitor. |
| **Graphic trends** (page 28-4) | Refer to *Trends*. |
| **HELP key** (page 1-11) | Touch the HELP monitor key and then a touchscreen key to display a description of that key's function. Touching the HELP key twice displays a window containing system information (model and software version) and configuration data. |
| **ICD** (page 31-6) | Implantable Cardiac Defibrillator. |
| **ICS** | Intesys Clinical Suite. |
| **Indication for Use** (page 31-1) | The devices documented herein are indicated for use by health care professionals whenever there is a need for monitoring of the physiological parameters of patients. |
| **Intended Use** (page 31-1) | The devices documented herein are intended to be used for monitoring of multiple physiological parameters for patients of any age ranging from neonates through adults. In addition to monitoring physiological parameters, these devices also support recording and alarming for those parameters.<br><br>The devices documented herein are not therapeutic devices. The devices documented herein are to be used by trained health care professionals in health care facilities. ST segment monitoring is restricted to adult patients only. The devices documented herein are not intended for home use. |
| **Invasive pressure** (page 20-3) | Uses an intravascular strain-gauge transducer to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures. |
| **Labels** | The name that appears on a parameter key, such as a pressure key label (ART, PA, PRS, CVP, etc.). |
| **Local Calcs** (page 27-5) | Refer to *Calculations* and *Drug Dosage Calculations*. |
| **Local Trends** (page 28-3) | Refer to *Trends*. |
| **Masimo SET** (page 17-7) | A pulse oximetry technology developed by Masimo. |
| **Mainstream and sidestream capnography** | Highly accurate methods of measuring respiratory gas values. |

| | |
|---|---|
| **Module Configuration Manager (MCM)** | Define and store user-configurable options within your module. For more information, refer to the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx). |
| **Module housing** (page 1-6) | A lightweight, standalone unit that allows the monitor to support additional parameter modules. |
| **MONITOR SETUP key** (page 1-11) | Displays a menu for entering patient demographic data, modifying the display format, adjusting tones, and specifying printing settings. |
| **Montage** | Used in BIS monitoring to view or enter electrode lead placement, enable EMG, and initiate continuous impedance testing. |
| **Multigas analyzer** (page 24-1) and (page 25-1) | Monitors gas concentrations and alerts clinical personnel when the concentration of anesthetic agents, oxygen, carbon dioxide, or nitrous oxide falls outside of defined limits. |
| **Multiparameter telemetry** | Digital telemetry product with options to acquire $SpO_2$ and NIBP data, as well as ECG data. |
| **Multiview I and II** (page 11-3) | Enhanced (Multiview I) and expanded (Multiview II) arrhythmia detection and alarms. Multiview II also offers storage and review capabilities. |
| **Networking** (page 1-14) | View and interact with parameter data from bedside to bedside, and from bedside to central monitor. |
| **Noninvasive Blood Pressure (NIBP)** (page 16-1) | NIBP uses oscillometric monitoring to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures. |
| **NORMAL SCREEN key** (page 1-11) | Returns the monitor to its basic display. |
| **Nurse Alert** | An optional external monitor configuration accessory. |
| **OCR** | Refer to oxycardiorespirogram. |
| **OxiMax** (page 17-14) | A pulse oximetry technology developed by Nellcor. |
| **Oxycardiorespirogram** (page 14-3) | A graph displaying heart rate, $SpO_2$, and respiratory rates. |
| **Pacemaker** (page 10-15) | A cardiac pacemaker. |
| **Parameter priority and color** (page 3-8) | Allows control of parameter position and color on the display. |
| **Patient Data Logger (PDL)** (page 30-3) | An option that automatically sends patient vital signs from the monitor to an external device, such as a printer or a terminal. |

| | |
|---|---|
| **Patient identification string** | A text string used to identify the patient associated with remotely viewed data. |
| **Physiologic calculations** | Refer to *Calculations*. |
| **Plethysmograph** (page 17-11) | Associated with $SpO_2$. |
| **Power failure** (page 1-7) | Loss of mains power. Refer to *Battery backup* on page 2-2. |
| **Pressure** | Refer to *Invasive Pressure*. |
| **PREVIOUS MENU key** (page 1-11) | Move backwards through prior menu levels one at a time. |
| **Printer module** (page 9-5) | A module that prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data. |
| **Printing priorities** (page 9-7) | Recording requests are printed in a priority order. |
| **Privileged access** (page 3-15) | Additional features available to any user with an appropriate password. |
| **Product specifications** (page 31-1) | A chapter in this manual that provides specifications for Spacelabs Healthcare products. |
| **Pulse oximetry ($SpO_2$)** (page 17-5) | Allows continuous noninvasive monitoring of a patient's hemoglobin oxygen saturation. |
| **Pulse pressure variation** (page 20-12) | Pulse pressure variation (PPV) can help clinicians to evaluate a patient's fluid volume status through the characterization of changes in the invasive pressure waveform in relation to respiration. |
| **QRS tone** (page 3-15 and page 10-21) | A tone that occurs each time a QRS complex is detected. |
| **Quicknet™** | Hospitals may choose to install additional network connections in patient rooms or hallways that are not permanently connected to a Spacelabs Healthcare monitor. These additional connections give hospitals greater flexibility in using their floating monitors during periods of high patient census, etc. |
| **Quickstarts** (page 1-3) | Quickstarts explain how to access and use features of the Spacelabs Healthcare monitors. |
| **Real-time ST trends** (page 12-13) | An ECG feature that displays 15 or 30 minutes of ST trend data at all times. |
| **Receivers** (page 18-11) | Used with a patient-worn telemetry transmitter to provide continuous monitoring of electrocardiographic signals. |

| | |
|---|---|
| **RECORD key** (page 1-11) | Touching this key prints monitored and parameter data using a bedside printer, system printer, or printer module. |
| **Recording destination** (page 9-18) | Enables you to direct alarm recordings to a bedside printer, a network printer, or both. Other recordings can be directed to a bedside printer or to a network printer, but not to both. |
| **Remote calcs** (page 27-5) | Display of calculated data from a remote monitor on the network. |
| **Remote keypad** (page 29-3) | A cordless, hand-held transmitter that sends instructions, via infrared signals, to the monitor's receiver. Provides all the functions needed to operate the monitor remotely. |
| **Remote monitor** | Any other monitor on the network. |
| **Remote trends** (page 28-3) | Display of vital sign trends from a remote monitor on the network. |
| **Remote View** (page 1-14) | View and control parameter data from a remote monitor on the network. |
| **Reports** (page 13-3) | 12-lead ECG reports. |
| **Respiration** (page 14-3) | Changes in thoracic impedance during patient inspiration and expiration provided through the ECG cable. |
| **Sensorwatch®** (page 17-12) | A graphical presentation of the amplitude of the signal received from the sensor that can be used to determine the best sensor site and application. |
| **SL2400 monitor** (page 3-5) | The SL2400 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2400 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules. |
| **SL2600 monitor** (page 3-5) | The SL2600 is a mid-range, compact monitor with a 12.1-inch touchscreen display. It is designed for bedside and portable use. The SL2600 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules. |
| **SL2700/SL2800 monitors** (page 3-5) | Bedside monitors that use external displays and accommodate two single-high parameter modules. |

| | |
|---|---|
| **SL3800 monitor** (page 4-5) | A central monitor that displays patient-specific parameters, remote alarms, and alarm limits based on the settings of the bedside monitor, as determined by the primary caregiver. |
| **SPECIAL FUNCTIONS key** (page 1-11) | Displays a menu for performing Remote View and Alarm Watch, viewing trends and clinical and drug calculations, and using other optional network applications, such as WinDNA®. |
| **$SpO_2$ tone** (pages 3-15, 10-21, and 17-19) | A tone that occurs each time an $SpO_2$ pulse is detected. |
| **ST analysis** (page 12-3) | Monitors changes to the ST segment level. |
| **ST segment review** | A review feature associated with the ST segment analysis feature. |
| **Standard networking** (page 1-14) | View and interact with parameter data from bedside to bedside monitor, and from bedside to central monitor. |
| **Status messages** | Indicate a problem or condition that may affect accurate monitoring values. |
| **Symbols** (page A-1) | A chapter in this manual that provides graphical illustrations of the symbols used on Spacelabs Healthcare products. |
| **Tabular trends** (page 28-5) | A table displaying up to 22 rows and 7 columns of continuous or episodic parameter data. |
| **Telemetry** | Refer to *Digital Telemetry*. |
| **Temperature** (page 19-3) | Refer to *Temperature*. |
| **Titration tables** (page 27-25) | The Drug Dosage calculation feature includes titration tables that appear for each drug record to calculate flow rate and dose. |
| **TONE RESET key** (page 7-11) | Silences the alarm tone for 45 seconds at that monitor. |
| **Transmitters** (page 18-3) | Small, battery-powered devices that monitor ECG activity and, optionally, $SpO_2$/NIBP data, and transmit this information to the digital telemetry receiver module. |
| **Trends** (page 28-3) | Numeric data collected for a patient over a 24-hour period that is displayed in either a graphical or tabular format. |
| **Troubleshooting information** | A section located at the end of most chapters that suggests solutions to common problems. |
| **Varitrend® 4** (page 15-3) | An optional feature in some 91496 modules. The Varitrend graph provides a real-time, continuous display of heart rate, respiration rate or compressed respiration waveform, $SpO_2$ (pre- and post-ductal sites), $EtCO_2$, as well as $TcpCO_2$, and $TcpO_2$. |

| | |
|---|---|
| **VCRR** | View, control, review, and record data displayed by Spacelabs Healthcare monitors. |
| **Venous oxygen saturation ($SvO_2$)** (page 22-3) | A status indicator of the oxygen transport system in critically ill patients. |
| **Venous stasis** (page 16-12) | Uses the NIBP cuff as the tourniquet for venous cannulation. |
| **Vitals report** (page 9-22) | A manual report on 50 mm roll paper of selected parameter data that prints on the SL2400/SL2600 compact monitor printer. |
| **Vital signs trending** | Refer to *Trends*. |
| **WFI** (page 17-11) | $SpO_2$ waveform index. |

# Bedside Monitors

## Directory of Keys




*Refer to Introduction*










*Refer to Alarms*




*Refer to Printing*







*Refer to Introduction*

**SL2400/SL2600 monitor only**

### SPECIAL FUNCTIONS

| REMOTE VIEW | ALARM WATCH | RV/AW OFF | ALARM LIMIT REVIEW | LOCAL TRENDS/ CALCS | REMOTE TRENDS/CALCS | DATA LOGGER | DNA |
|---|---|---|---|---|---|---|---|
| *Refer to Introduction* | | *Refer to Alarms* | | *Refer to Trends and Calculations* | | *Refer to page 3-7* | *Refer to page 5-1* |

### MONITOR SETUP

| TONES | ADMIT/ DISCHARGE | MONITOR CONFIG. | RECORDER CONFIG. | PRIVILEGED ACCESS |
|---|---|---|---|---|
| *Refer to Alarms* | *Refer to Admit/Discharge* | | *Refer to Printing* | *Refer to page 3-2 and page 3-3* |

### MONITOR CONFIGURATION

| ENERGY SAVING MODE | | OR | SCREEN BRIGHTNESS | | MINOR GRATICULE | PARAMETER CONFIG | CLOCK | | ALARM LIGHT | | ACTIVATE SCREEN SAVER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ON | OFF | | NORMAL | DIM | | | ON | OFF | ON | OFF | |
| *DC Power* | | | *AC Power* | | | | | | | | |

### MINOR GRATICULE - 2 divisions

| MINOR GRAT | | ↓ | ↑ |
|---|---|---|---|
| ON | OFF | | |

# Privileged Access




*Refer to Introduction* | | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter clinical password and touch ENTER*

**SL2400/SL2600 monitor only**

**CLINICAL LEVEL - Select Parameter**

| TIME/ DATE | PRESELECTED RECORDINGS | UNITS OF MEASURE | USER ACCESS | ALARM SETUP | ALARM WATCH SETUP | MORE |
|---|---|---|---|---|---|---|
| | *Refer to Printing* | | | *Refer to page 3-3* | *Refer to page 3-3* | *Refer to page 3-3* |

**USER ACCESS - Enable user access to functions**

| PATIENT TYPE | | PARAMETER CONFIG | | RECORDING DURATION | | SUBNET ACCESS | | DEFAULT ENG. SAV MODE | |
|---|---|---|---|---|---|---|---|---|---|
| ON | OFF | ON | OFF | ON | OFF | ON | OFF | ON | OFF |

**Restart monitor after selecting units of measurement**

| | | |
|---|---|---|
| mmHg | inches | lb |
| kPa | cm | kg |

**MONITOR SETUP - Time/Date 10:06 AM/PM**

| TIME / DATE | 24 HOURS | AM / PM | HOURS | MINUTES | ↑ | ↓ | ENTER |
|---|---|---|---|---|---|---|---|

## Privileged Access (continued)




*Refer to Introduction* | | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter clinical password and touch ENTER*

**CLINICAL LEVEL - Select Parameter**

| TIME/ DATE | PRESELECTED RECORDINGS | UNITS OF MEASURE | USER ACCESS | ALARM SETUP | MORE |
|---|---|---|---|---|---|
| *Refer to page 3-2* | *Refer to Printing* | *Refer to page 3-2* | *Refer to page 3-2* | | |

**CLINICAL LEVEL - Select Parameter**

| ALARM WATCH SETUP | REMOTE KEYPAD STATION ADDRESS | CHANGE CLINICAL PASSWORD | RESET MONITOR |
|---|---|---|---|

**ALARM WATCH SETUP - Select parameter to change**

| ROTATE ALARM WATCH | | ALARM WATCH ROTATION | | ROTATION TIME | |
|---|---|---|---|---|---|
| ON | OFF | PRIORITY | SIMPLE | 15 S | 30 S |

**ALARM SETUP - Select parameter**

| REMOTE ACCESS | | ALARM SUSPEND | | TREND SUSPEND | | ALARM RELAY | MORE |
|---|---|---|---|---|---|---|---|
| ON | OFF | ON | OFF | ON | OFF | | |

**ALARM SETUP - Select parameter**

| QRS/SPO2 TONE ENABLE | | ALARM WATCH TONE | |
|---|---|---|---|
| ALWAYS | DURING ALARM | SINGLE | TRIPLE |

**ALARM RELAY SETUP - Select parameter**

| RELAY TIMEOUT | | FLASHING | ALARM LEVEL |
|---|---|---|---|
| 0 SEC | 10 SEC | STEADY ON | |

**ALARM LEVEL - Select minimum alarm priority level to trigger relay activation**

| HIGH | MEDIUM | LOW |
|---|---|---|

# Bedside Monitors

## Contents

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## Overview

Parameter modules that are inserted into the monitor itself or into a module housing acquire patient data to display as waveforms and numerics.

The bedside monitor can (optionally) display up to eight parameter zones. If more than eight zones are used, numeric keys appear at the bottom of the display for the additional parameters. When you activate a numeric key, that parameter is displayed in the lowest-priority display zone.

***Warning:***

- ***Do not use cables or sensors that exhibit obvious damage. Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage.***
- ***If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.***
- ***Do not operate electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) within 1.07 meters (3.5 feet) of the patient, patient leads, or associated monitoring equipment until evaluated by the biomedical engineering staff. Electromagnetic interference may occur when using these devices.***

Spacelabs Healthcare monitors and modules have built-in error detection and recovery circuitry that allows the monitor to re-initialize and continue to function if an error occurs. Spacelabs Healthcare monitors also provide battery backup to ensure that patient trends and demographic information is not lost in the event of a short-term power interruption, such as backup generator testing.

When the system detects an error that cannot be corrected through other means, the monitor re-initializes or resets (blanks). Normally, a reset involves very little loss of patient monitoring time (approximately five seconds) and, with few exceptions, all configured user settings (alarm limits, pressure labels, transducer offsets, etc.) are retained. The entire process of restoring the monitor following a reset takes approximately 20 seconds, depending upon the number of parameters being monitored.

In some cases, stored trend data is lost when the monitor resets. Typically, this is indicative of a hardware condition requiring corrective action. In this case, the system initiates the start-up diagnostics to check the monitor's operation, so that full recovery takes approximately 10 seconds longer.

**Caution:**

- **Use of the monitor is restricted to one patient at a time.**
- **Using multiple instances of parameters such as ECG is not supported.**

***Note:***

- *When measured parameter values are above the monitor's designated range, then these symbols appear in place of numerics:* ***+++****.*
- *When measured parameter values are below the monitor's designated range, then these symbols appear in place of numerics:* ***---****.*

## Check Setup

If a bedside monitor resets, a CHECK SETUP key may appear in the ECG zone, and a low priority alarm tone sounds to alert you to check all limits and values and ensure that the monitor has restored all preset values. To cancel the message and the alarm, touch the CHECK SETUP key.

**The following events cause the CHECK SETUP key to appear:**

- The monitor is powered ON — All parameters reset to their default values or to the values set the last time the monitor was in use.
- An ECG module is inserted — The module values display default settings.
- An error is detected that cannot be corrected through other means — The monitor resets.

Check Setup is an optional feature on the ECG parameter that your system administrator can enable and disable.

# Display Detail



SL2700/SL2800 bedside monitor with touchscreen display



SL2400 bedside monitor or portable monitor



SL2600 bedside monitor or portable monitor

*Figure 3-1: Bedside monitors*

# Identifying Special Applications

If your monitor has access to special applications, additional keys identifying those functions appear in the **Special Functions** menu. Touch the SPECIAL FUNCTIONS key to access these applications.

**Special applications include:**

- **Patient Data Logger** — Enables you to automatically send patient vital signs from the monitor to an external device, such as a printer or a terminal (refer to *Patient Data Logger* on page 30-3*)*.
- **Dynamic Network Access (DNA)** — a Spacelabs Healthcare proprietary version of the Citrix ICA Client that provides the ability to connect and interact with remote applications hosted on Citrix servers. Your hospital administrator (or other designated personnel) must first set up communication between the Ultraview SL monitor and server locations and/or applications before DNA can be used. Refer to the *91370A Service Manual* (P/N 070-1315-xx) or the *91387 Service Manual* (P/N 070-1159-xx), located on CD-ROM 084-0700-xx, for information on DNA configuration.

**To access DNA:**

- Touch SPECIAL FUNCTIONS.
- Touch DNA.

***Note:***

- *Ensure that any computer or communications equipment connected to the network complies with applicable medical standards.*
- *DNA is not available on 91369-24 and 91387-27 models.*

# Monitor Configuration Features

**The Monitor Configuration menu allows you to:**

- Adjust display brightness (refer to *Adjusting Display Brightness and Contrast* on page 3-8)
- Set parameter priorities and colors (refer to *Setting Priorities and Colors* on page 3-8)
- Adjust minor graticule lines (refer to *Using Scaled Displays* on page 3-12)
- Access the clock menu (refer to *Using the System Clock* on page 3-12)
- Activate the screen saver (refer to *Activating the Screen Saver* on page 3-13)

## Adjusting Display Brightness and Contrast

You can increase or decrease the display brightness on the SL2400/SL2600 monitors using the **Monitor Setup** menu. The brightness and contrast of the SL2700/SL2800/SL3800 monitors are adjusted through the display's on-screen menus. Refer to the individual monitor display user manual for additional information.

**To adjust display intensity (SL2400/SL2600 only):**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch SCREEN BRIGHTNESS NORMAL/DIM.

SL2400/SL2600 monitors operating on AC power contain a SCREEN BRIGHTNESS key, enabling you to set the display to NORMAL or DIM. Setting the display to DIM also enables the power saving features, such as shutting off the LEDs and disabling the mouse and keyboard. The display will also dim approximately 30 seconds after the last time a key is touched, or after the final alarm ends.

SL2400/SL2600 monitors operating on DC (battery) power contain an ENERGY SAVING MODE ON/OFF key that enables and disables the power saving features.

## Setting Priorities and Colors

Each parameter displays in the order of its assigned priority. The highest priority appears at the top of the display with the number 1.

The **Parameter Config.** dialog box enables you to change the priority and color of parameters. *Table 1* on page 3-11 lists default priorities and colors for each parameter.

## DISPLAY PRIORITIES

The DISPLAY PRIORITIES key lists all the current bed's supported parameters (ALL), or a selected subset of parameters (CUSTOM). Touching ALL will display all the monitor's supported parameters.

Touching CUSTOM displays only the subset of parameters the user has selected, such as the parameters used most frequently.

Use the arrows keys to move the parameters between the CUSTOM LIST and the full parameters list. Or, if parameters are already listed under CUSTOM LIST, touch a parameter from the full list, and then touch the desired position under CUSTOM LIST. The new parameter replaces the position of the previous parameter under CUSTOM LIST.

Using the arrows keys to move the parameters from the full list to CUSTOM LIST places the parameter in the lowest position. To change the order of a parameter, touch that parameter, then touch the position you wish to place the parameter.

***Note:***

- *You can configure parameter priorities and positions without the parameter module present.*
- *Your monitor may not allow changes to parameter priorities or colors. Contact your system administrator for details.*

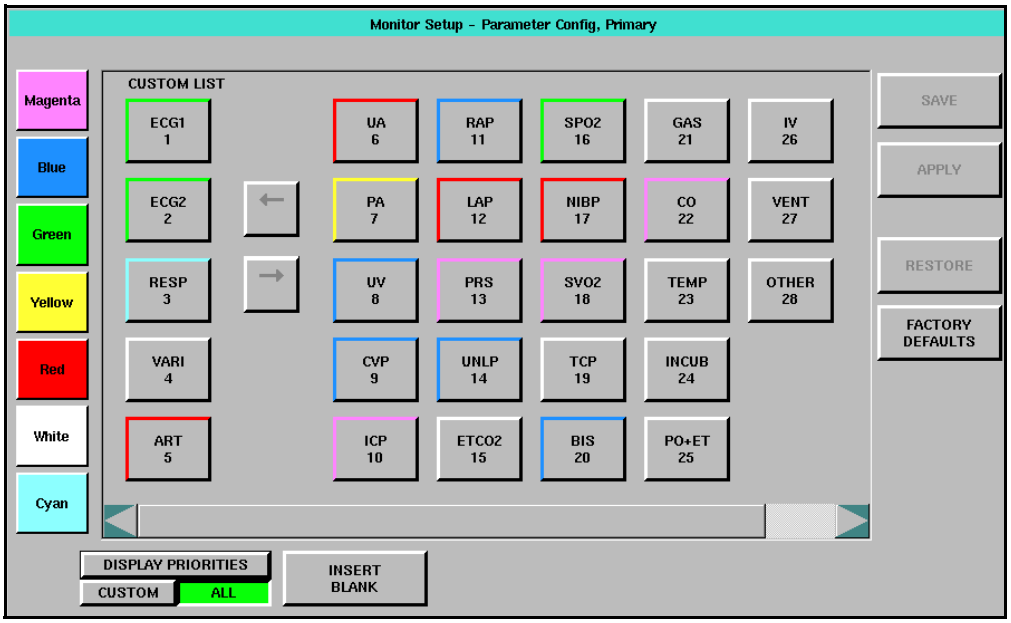



*Figure 3-2: Parameter Config. dialog box (ALL selected)*

**To change a parameter priority or color:**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch PARAMETER CONFIG.
- Select a parameter.
- Touch the left arrow to move the *first* parameter into the CUSTOM LIST.

  -OR-
- Select the destination priority by touching the position in the CUSTOM LIST column (all subsequent parameters).
- Select a color.
- Select the parameter key to be colored (the key and waveform will appear in the chosen color).
- Touch SAVE to store local color and priority settings.

### INSERT BLANK

The INSERT BLANK keys enable you to insert a space above or below a parameter. Blanks can be inserted by touching the blank key and then inserting the blank key space into the desired location. After selecting a blank, touch APPLY or SAVE. A blank zone then occupies the corresponding position on the display. All other active parameters move down.

To remove a blank key, touch the blank key then touch the right arrow to move it out of the CUSTOM LIST.

### SAVE

The SAVE key saves and applies all current settings, including all changes made.

### APPLY

The APPLY key applies any changes made to the priority and color settings of the current display, but does not save those changes when the monitor is powered OFF. Changes made to a configuration take effect after touching APPLY.

To retain configuration changes after the monitor is powered OFF, you must select SAVE.

### RESTORE

The RESTORE key discards any changes made to the settings that have not been saved. Touching RESTORE then touching APPLY reverts to the last-saved settings.

## FACTORY DEFAULTS

The FACTORY DEFAULTS key resets the factory-default priority and color settings, but does not save them.

*Table 1: Parameter Priorities and Colors*

| Parameter Type | Description | Default Priority | Default Color |
|---|---|---|---|
| ECG1 | Electrocardiogram (first lead) | 1 | Green |
| ECG2 | Electrocardiogram (second lead) | 2 | Green |
| RESP | Respiration | 3 | Cyan |
| VARI | Varitrend | 4 | White |
| ART | Arterial Pressure | 5 | Red |
| UA | Umbilical Artery Pressure | 6 | Red |
| PA | Pulmonary Arterial Pressure | 7 | Yellow |
| UV | Umbilical Vein Pressure | 8 | Blue |
| CVP | Central Venous Pressure | 9 | Blue |
| RAP | Right Atrial Pressure | 10 | Blue |
| ICP | Intracranial Pressure | 11 | Magenta |
| LAP | Left Atrial Pressure | 12 | Red |
| PRS | Other Pressure (general) | 13 | Magenta |
| UNLP | Unlabeled Pressure | 14 | Blue |
| $EtCO_2$ | End Tidal $CO_2$ (Capnography) | 15 | White |
| $SpO_2$ | Pulse Oximetry ($O_2$ saturation) | 16 | Green |
| NIBP | Noninvasive Blood Pressure | 17 | Red |
| $SvO_2$ | Venous $O_2$ Saturation | 18 | Magenta |
| TCP | Partial Pressure of Transcutaneous $O_2$ | 19 | White |
| BIS® | Bispectral Index | 20 | Blue |
| GAS | Gas Analyzer | 21 | White |
| CO | Cardiac Output | 22 | Magenta |
| TEMP | Temperature | 23 | White |
| INCUB WARMR | Incubator/Warmer | 24 | White |

*Table 1: Parameter Priorities and Colors (continued)*

| Parameter Type | Description | Default Priority | Default Color |
|---|---|---|---|
| PO + ET | $SpO_2$ and $EtCO_2$ Flexport System Interface | 25 | White |
| IV | Infusion Flexport System Interface | 26 | White |
| VENT | Ventilator Flexport System Interface | 27 | White |
| OTHER | | 28 | White |

***Note:***

*When using an older EEG module, the parameter will display as BIS.*

## Using Scaled Displays

Bedside monitors display up to four scaled pressures simultaneously (refer to *Pressure* on page 20-3). Monitors optionally display minor graticule lines that can be adjusted. Minor graticules are small, dashed line segments that appear between the full-scale graticule lines.

**To adjust the scaled display:**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch MINOR GRATICULE.
- Select MINOR GRAT / ON.
- Use the arrow keys to adjust.

## Using the System Clock

A system clock can be continually displayed in the lower-right corner of the display. The digital clock is available on all monitors. The SL2700/SL2800/SL3800 monitors also display a stopwatch or timer.

***Note:***

*The SL2700/SL2800/SL3800 monitor timer function will not produce an audio chirp when the countdown completes if an audio alarm is occurring.*




Digital Stopwatch Timer

*Figure 3-3: Clock display formats*

**To access the clock menu (SL2700/SL2800/SL3800 only):**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch CLOCK ON.
- Touch the clock that appears in the lower right of the display.
- Select DIGITAL, STOPWATCH, or TIMER.

## Activating the Screen Saver

Activating the screen saver displays a blank screen (displaying only the Spacelabs Healthcare logo). The screen is automatically restored by an incoming alarm condition. To disable the screen saver, touch the display, move the mouse, or press any key on the keyboard.

**To activate the screen saver:**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch ACTIVATE SCREEN SAVER.

# Wireless Networking (SL2400/SL2600 Only)

SL2400/SL2600 monitors have optional features and configurations that support wireless network communication.

## Signal Strength Indicator

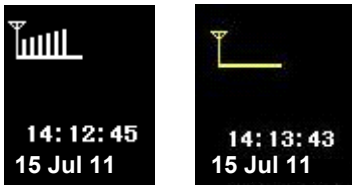



*Figure 3-4: Wireless signal strength indicator*

Monitors that support wireless network communication display a wireless signal strength indicator when communicating over the wireless network. To use wireless communication, the wired network connector must be physically disconnected.

The wireless signal strength indicator is directly below the NORMAL SCREEN key and above the clock. This indicator is left-justified to leave room for monitors to display channel information related to the wireless remote control.

On portable monitors (SL2400/SL2600), the signal strength indicator displays directly above the battery gauge (refer to *Battery Gauge* on page 3-20). For adequate signal strengths, the indicator displays as white on a black background. The signal strength indicator changes to yellow when the signal strength is low. In *Figure 3-4*, adequate signal strength is shown on the left, and low signal strength is shown on the right.

### Caution:

**Environmental factors can contribute to waveform gaps over the wireless network. Should this be a persistent issue, consult with a biomed technician or a Spacelab Healthcare field service representative.**

# Privileged Access Menus

Several additional features are available to any user with a Clinical level of Privileged Access.

## Setting the Time and Date

The TIME/DATE key accesses both the time and date menus. The current time or date appears above the menu. Time appears in either a 12- or 24-hour format. Networked monitors display the network time and stand-alone monitors display the internal system time. Time or date changes are not permanent until you touch ENTER on the display.

Setting the time on any networked monitor sets the time for all monitors on that network.

**To change the network or internal system time and date:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter Clinical password.
- Touch TIME/DATE.

- Select TIME.
- Select 24 HOURS or AM/PM (12 hours).
- Select HOURS or MINUTES and use the arrow keys to set time.

**-OR-**

- Select DATE.
- Touch MONTH, DAY, or YEAR and use the arrow keys to set the date.

- Touch ENTER.

## Setting QRS Tones

Your monitor can be configured to sound a tone whenever an R-wave (QRS tone) or $SpO_2$ pulse ($SpO_2$ tone) is detected (this is the default setting) or only when an alarm is occurring. The pitch of the QRS tone can be modulated with the current $SpO_2$ value.

Your monitor has two options for how the QRS or $SpO_2$ tone sounds, if it has been enabled via either parameter's TONE ON/OFF key. Refer to *Adjusting Tones* on page 10-21 and *Adjusting Tone Volume* on page 17-19 for more information.

**To set QRS tones:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch ALARM SETUP.
- Touch MORE.
- Select QRS/SPO2 TONE ENABLE / ALWAYS or DURING ALARM.

# Data Shuttle Option

The Data Shuttle option enables you to transfer patient demographic data (e.g., age, gender, name, and BSA) and up to 24 hours of trend and episodic data from one monitor to another. This feature transfers data acquired using any Spacelabs Healthcare module or Flexport system interface.

Before you shuttle data from one monitor to another, you must first transfer the data from the source monitor into a Command module. When you remove the module from the source monitor and insert it into the receiving monitor, data can be transferred to the receiving monitor.

***Note:***

- *Before inserting the Command module into the receiving monitor, discharge or purge the data at the receiving monitor.*
- *If the module has been out of the monitor for 10 or more minutes, all data will be lost.*
- *The time and date set on both the sending and receiving monitors must be identical for the data transfer to be successful.*

## Transferring Data to the Module

If your monitor and module support the Data Shuttle option, a TRANSFER DATA key displays in the **ECG Setup** menu. When you wish to transfer data (for example when transporting a monitored patient from one unit to another), touch the TRANSFER DATA key to transfer data into the module. The message *TRANSFERRING PATIENT DATA INTO MODULE* appears.

Once the data is completely transferred, the monitor sounds a tone and the message *DATA TRANSFER COMPLETED* appears below the UPDATE TRANSFER and CANCEL TRANSFER keys. The module is now ready to be removed from that monitor. To provide seamless trend information, remove the module and insert it into the receiving monitor within 30 to 45 seconds after you transfer the data. If there is a delay in completing the data shuttle, update the transfer data just before you remove the module.

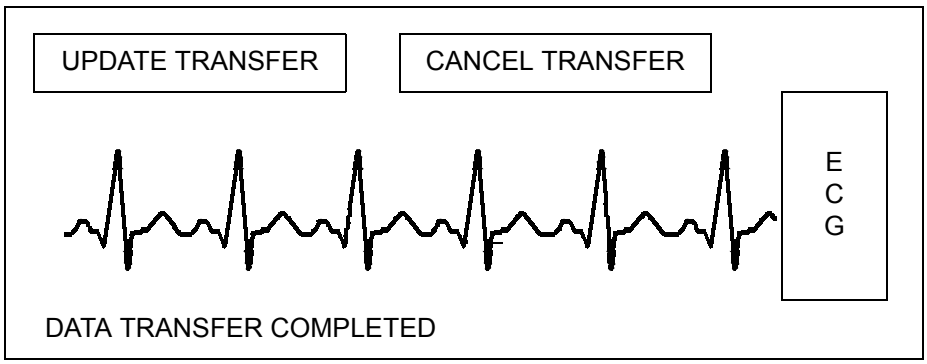



*Figure 3-5: Data Transfer Completed message*

If you do not transfer the module to the receiving monitor immediately, the source monitor will be storing new data, but the module's transfer data is not automatically updated. Parameter information acquired between the time you transfer data and the time you remove the module is lost. The monitor indicates this lost information as a gap in the trends of the parameters involved when you retrieve the data.

After two minutes, a tone will sound once each minute to remind you to update the module with the newly acquired data and the message *DATA TRANSFER COMPLETED, DATA IS XX MINUTES OLD* appears on the monitor. This is the amount of time that has elapsed since you last transferred the data. The monitor updates this message each minute.

If time elapses between data transfer into the module and module removal, you may wish to update the transferred data before you remove the module. To update this data, touch UPDATE TRANSFER. While the data is being updated, the monitor re-displays the message *TRANSFERRING PATIENT DATA INTO MODULE*.

Touch the CANCEL TRANSFER key to clear all data transfer messages and keys from the ECG display zone and purge previously transferred data from the module. The monitor will then reactivate the TRANSFER DATA key in the **ECG Setup** menu.

**To transfer data:**

- Touch ECG.
- Touch SETUP.
- Select TRANSFER DATA.
- Remove the module after DATA TRANSFER COMPLETED displays.

**To update transfer data, touch UPDATE TRANSFER.**

**To cancel data transfer, touch CANCEL TRANSFER.**

## Retrieving Transferred Data

When you insert the module into the receiving monitor, the monitor displays the RETRIEVE DATA and CANCEL TRANSFER keys and sounds a low priority alarm tone until you either cancel the data transfer or retrieve the data. The monitor also displays the patient name associated with the data to be transferred and, if applicable, the patient name associated with the data that currently resides in the monitor.

The Admit/Discharge feature does not allow you to purge a prior patient's data if you insert a module loaded with transfer data. If you attempt to purge patient data in this manner, the following message appears: *Purge is not allowed during transport*.

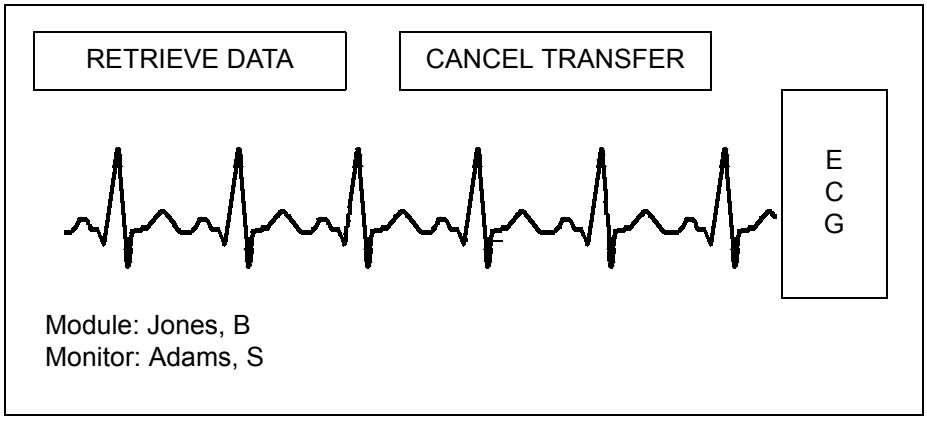



*Figure 3-6: Retrieving Transfer Data display*

**When you touch the RETRIEVE DATA key, the monitor displays YES and NO keys along with the following message:**

*YES purges the monitor's data and retrieves data from the module.*

*NO cancels this action.*

Touch NO to return to the previous screen. Touch YES to transfer the data from the module into the receiving monitor and purge any data previously stored in that monitor.

Once you initiate data retrieval, the monitor removes all data-transfer-related keys from the ECG display zone and displays the message *TRANSFERRING PATIENT DATA INTO MONITOR*. When the data retrieval into the monitor is complete, the message *DATA TRANSFER COMPLETED* appears for one minute.

**To receive transferred data:**

- Touch RETRIEVE DATA.
- Touch YES.

**To cancel data transfer:**

- Insert the module into the receiving monitor.
- Touch CANCEL TRANSFER.
- Touch YES.

## Canceling the Data Transfer After Module Insertion

To cancel a data transfer, touch the CANCEL TRANSFER key.

**The monitor displays YES and NO keys along with the following message:**

*YES purges the data previously transferred into the module.*

*NO cancels this action.*

Touch YES to confirm the cancellation of the data transfer and reactivate the TRANSFER DATA key in the **ECG Setup** menu. Touch NO to return to the previous screen.

# Power and Battery Status (SL2400/SL2600 Only)

The three LEDs on the SL2400/SL2600 monitor indicate whether the monitor is connected to the AC mains power and the status of any installed batteries. Battery status conditions are indicated as described in the following sections.

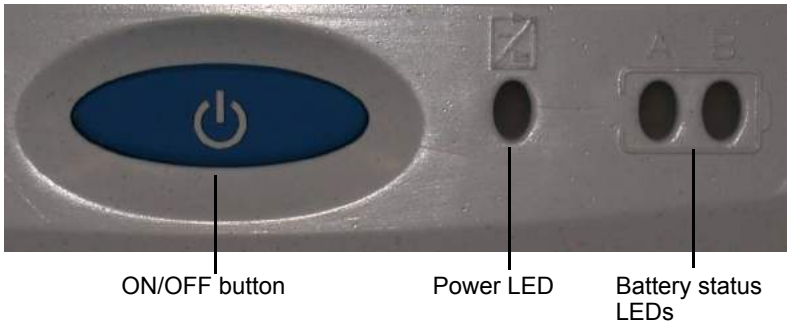



*Figure 3-7: Battery status information*

## Power LED

The power LED is located immediately to the right of the ON/OFF button. This LED is lit whenever the monitor is connected to AC mains power via its power supply, and is not lit if the monitor is not connected to the AC mains power.

## Battery LEDs

### Solid Green LED

A solid green battery LED indicates that the battery is fully charged. Only a charging cycle or a faulty battery will cause the green LED to flash, and these conditions only occur when a battery is installed in the monitor.

### Flashing Green LED — Battery Charging

A flashing green battery LED indicates an installed battery is being charged and the monitor is not ready for portable use. This LED flashes in a constant pattern with no delays with the monitor powered ON or OFF. The flashing is different than the battery fault detection flash.

***Note:***

*The green LED stops flashing and glows solid when the charging cycle is complete.*

### Intermittent Flashing Green LED — Battery Fault Detected

An intermittent flashing green LED indicates that the installed battery will not hold a charge or that it is taking too long to charge. The intermittent signal is a repeating pattern of a solid green LED for one second and a flashing LED for one second. An error message is also added to the error log for review by your system administrator.

To determine whether a battery is faulty, power the monitor ON using the front-panel switch and observe the message that appears along the bottom of the monitor display. Replace a faulty battery with the same battery type.

### Unlit LED

A battery LED that is neither solid ON nor flashing indicates that a battery is not present.

## Battery Gauge

The battery gauge is always present in the lower right corner of the display when the monitor is operating on batteries (powered ON and not plugged into AC power). This gauge indicates the approximate battery capacity.

**For example, the gauge will display:**

- A fully charged battery
- ¾ battery charge remaining
- ½ battery charge remaining
- ¼ battery charge remaining
- Minimum battery charge remaining

***Note:***

- *Printing drains large amounts of power and can cause the monitor to power OFF without warning. Therefore, printing is automatically inhibited when the battery power reaches the ½ charge remaining.*
- *When the battery power becomes critically low (approximately ¼ charge remaining), the entire battery gauge flashes to emphasize this warning. The monitor may power OFF at any time, depending upon how much power the monitor is using.*
- *Upon power OFF, the monitor will cease to function.*

# SL2400/SL2600 Monitor Connections

## External Power Supply and Network Connections

The connection for the external power supply is shown in *Figure 3-8*. The green LED to the right of the ON/OFF button on the front panel is ON whenever the unit is powered by an external power supply.

**To connect to an external power supply:**

- Attach the DC outlet cable to J1.
- Connect the power cord of the external power supply to an AC outlet.

**To connect to the 10/100BaseT port for network communication:**

- Plug either end of an Ethernet cable into the modular jack connection on the side of the monitor (refer to *Figure 3-9* on page 3-22).
  Network communication is done through the 10BaseT cable assembly only.
- Plug the other end of the cable into the wall in a wall plate with an 8-pin modular jack connector.

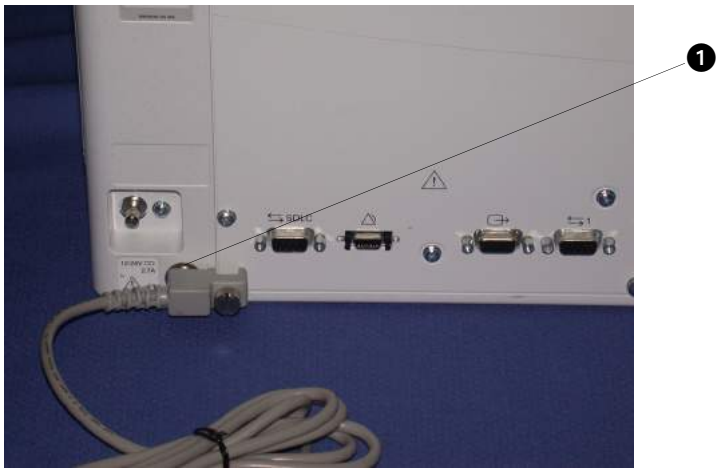



*Figure 3-8: SL2400/SL2600 power connection*

1 J1 - external power supply connection




*Figure 3-9: SL2400/SL2600 10/100BaseT network connection*

1. Modular jack connection
2. 10/100BaseT Ethernet cable

## External Flexport System Interface Connection

The SL2400/SL2600 monitors also provide an external Flexport system interface connection (refer to *Figure 3-10*).

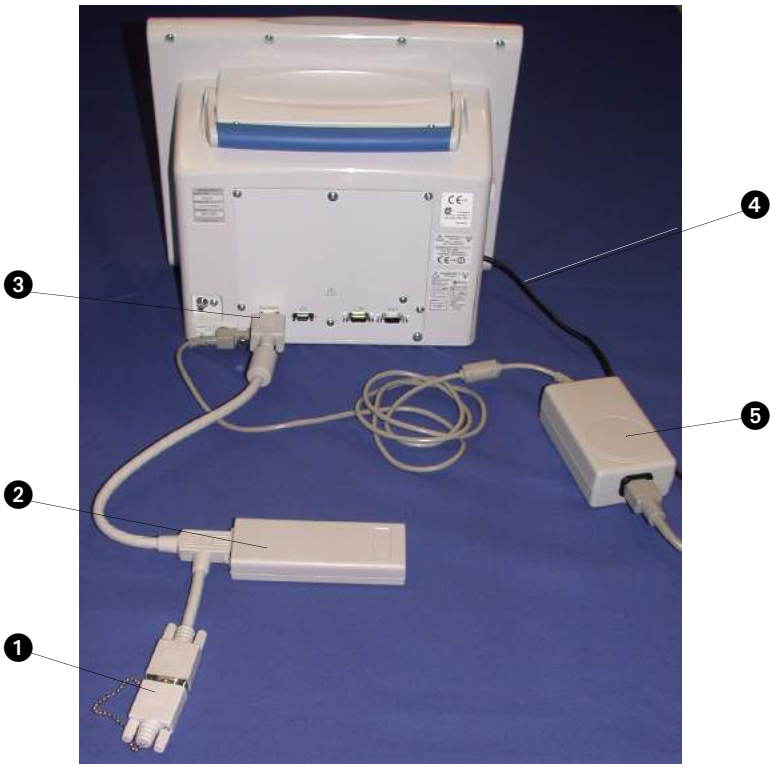



*Figure 3-10: SL2400/SL2600 monitor power and Flexport connections*

1. SDLC terminator
2. Flexport system interface
3. SDLC connection
4. 10/100BaseT Ethernet cable
5. External power supply

# Bedside Monitor Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Cannot change parameter priority or colors** | ■ Monitor may not be set up to allow the user to change priority or colors. | ■ Contact your system administrator. |
| **Changed parameter priority or colors are lost** | ■ The STORE key was not touched after the selection was made. | ■ Touch the STORE key to make changes permanent. |
| **SL2400/SL2600 monitor has no DC power** | ■ The monitor was not plugged into an AC outlet while not in use.<br>■ No batteries installed. | ■ Plug the monitor into an AC outlet to recharge batteries.<br>■ Install one or two batteries. |

# Central Monitors

## Directory of Keys




*Refer to Introduction*










*Refer to Alarms*




*Refer to Printing*







*Refer to Introduction*

**SPECIAL FUNCTIONS**

| ALARM WATCH | AW OFF | ALARM LIMIT REVIEW | REMOTE TRENDS/CALCS | DNA |
|---|---|---|---|---|
| *Refer to Alarms* | | | *Select a bed* | *Refer to page 5-1* |

**TRENDS/CALCS for BED XXX**

| GRAPHIC TRENDS | TABULAR TRENDS | CALCS | DRUG CALCS |
|---|---|---|---|

*Refer to Trends and Calculations*

**MONITOR SETUP**

| SCREEN FORMAT | TONES | ADMIT/ DISCHARGE | MONITOR CONFIG. | RECORDER CONFIG. | PRIVILEGED ACCESS |
|---|---|---|---|---|---|
| *Select the waveform zone*<br>*Select the bed (or subnet and then the bed)*<br>*Select the parameter* | *Refer to Alarms* | *Refer to Admit/Discharge* | | *Refer to Printing* | *Refer to page 4-2 and page 4-3* |

**MONITOR CONFIGURATION**

| CLOCK | | ACTIVATE SCREEN SAVER |
|---|---|---|
| ON | OFF | |

# Privileged Access




*Refer to Introduction* | | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction* | |

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter clinical password and touch ENTER*

**CLINICAL LEVEL - Select Parameter**

| TIME/ DATE | PRESELECTED RECORDINGS | UNITS OF MEASURE | USER ACCESS | ALARM SETUP | ALARM WATCH SETUP | MORE |
|---|---|---|---|---|---|---|
| | *Refer to Printing* | | | *Refer to page 4-3* | *Refer to page 4-3* | *Refer to page 4-3* |

**USER ACCESS - Enable user access to functions**

| PATIENT TYPE | | PARAMETER CONFIG | | RECORDING DURATION | | SUBNET ACCESS | |
|---|---|---|---|---|---|---|---|
| ON | OFF | ON | OFF | ON | OFF | ON | OFF |

**Restart monitor after selecting units of measurement**

| | | |
|---|---|---|
| mmHg | inches | lb |
| kPa | cm | kg |

**MONITOR SETUP - Time/Date 10:06 AM**

| TIME / DATE | 24 HOURS | AM / PM | HOURS | MINUTES | ↑ | ↓ | ENTER |
|---|---|---|---|---|---|---|---|

## Privileged Access (continued)




*Refer to Introduction* | | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter clinical password and touch ENTER*

**CLINICAL LEVEL - Select Parameter**

| TIME/ DATE | PRESELECTED RECORDINGS | UNITS OF MEASURE | USER ACCESS | ALARM SETUP | ALARM WATCH SETUP | MORE |
|---|---|---|---|---|---|---|
| *Refer to page 4-2* | *Refer to Printing* | *Refer to page 4-2* | *Refer to page 4-2* | | | |

**CLINICAL LEVEL - Select Parameter**

| REMOTE KEYPAD STATION ADDRESS | CHANGE CLINICAL PASSWORD | RESET MONITOR |
|---|---|---|

*Refer to Remote Keypad*

**ALARM WATCH SETUP - Select parameter to change**

| ROTATE ALARM WATCH | | ALARM WATCH ROTATION | | ROTATION TIME | |
|---|---|---|---|---|---|
| ON | OFF | PRIORITY | SIMPLE | 15 S | 30 S |

**ALARM SETUP - Select parameter**

| REMOTE ACCESS | | ALARM RELAY | QRS/SPO2 TONE ENABLE | | ALARM WATCH TONE | |
|---|---|---|---|---|---|---|
| ON | OFF | | ALWAYS | DURING ALARM | SINGLE | TRIPLE |

# Central Monitors

## Contents

Overview . . . . . 5
Display Detail . . . . . 6
Central Monitor Setup . . . . . 6
Central Monitor Troubleshooting Guide . . . . . 10

## Overview

The SL3800 central monitor provides full monitoring control of remote parameters, including displays and alarms with both visual and audible annunciation. All waveform and current numeric data, arrhythmia, ST segment, and trends are available with central monitoring.

Spacelabs Healthcare monitors and modules have built-in error detection and recovery circuitry that, together with special software, allow the monitor to re-initialize and continue to function if an error occurs. Spacelabs Healthcare monitors also provide battery backup to ensure that patient information is not lost in the event of a short-term power interruption, such as backup generator testing.

When the system detects an error that cannot be corrected through other means, the central monitor re-initializes or resets (blanks). Normally, a reset involves very little loss of patient monitoring time (approximately five seconds) and, with few exceptions, all user settings (alarm limits, pressure labels, transducer offsets, etc.) are retained. The entire process of restoring the central monitor following a reset takes approximately 20 seconds, depending upon the number of parameters being monitored.

In some cases, stored trend data is lost when the monitor resets. Typically, this is indicative of a hardware condition requiring corrective action. In this case, the system initiates the start-up diagnostics to check the monitor's operation so that full recovery takes approximately 10 seconds longer.

If a bedside monitor resets, the central and bedside monitors may display the CHECK SETUP key (refer to *Check Setup* on page 3-6) in the ECG zone to alert you to check all limits and values and ensure that the monitors have restored all preset values. This also occurs when the monitors are powered ON, or when an ECG module has been inserted.

***Warning:***

- ***If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.***
- ***Because of the potential for electromagnetic interference, electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) should not be operated within 3.5 feet (1.07 meters) of the patient, patient leads, or associated monitoring equipment until evaluated by the biomedical engineering staff.***

# Display Detail

The central monitor can accommodate up to 8 full-width display zones, or up to a maximum of 12 or 16 half-width zones on a split-view display. The SIX-TRACE-mode automatically reformats the display to increase the font and zone sizes for alphanumeric text. The larger font and zone sizes always appear on central monitors configured for 4-, 5-, 6-, and 12-zone operation, because no more than 6 full zones can have parameters assigned to them.

***Note:***

- *When measured parameter values are above the monitor's designated range, then these symbols appear in place of numerics:* **+++***.*
- *When measured parameter values are below the monitor's designated range, then these symbols appear in place of numerics:* **---***.*

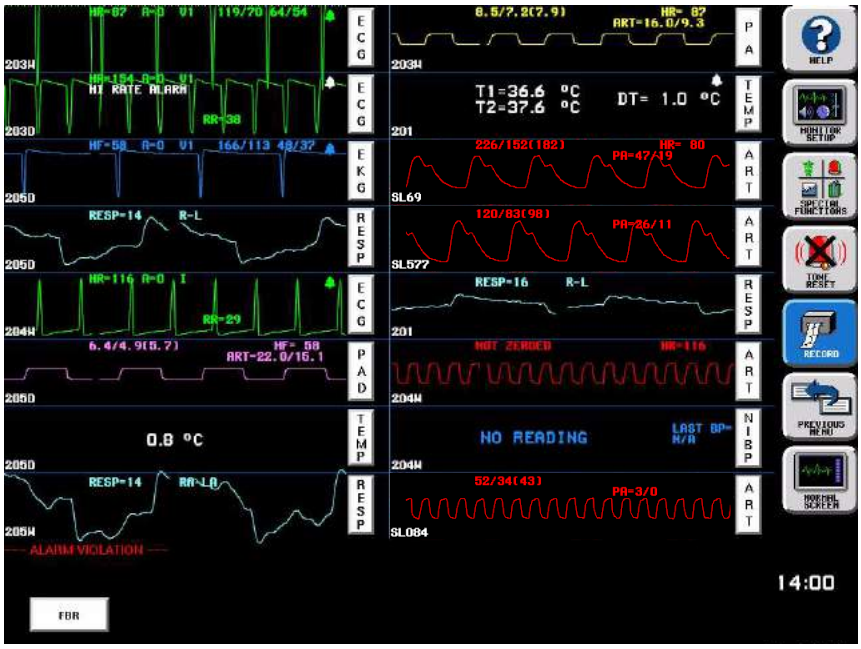



*Figure 4-1: Split-view display option showing 16 zones*

# Central Monitor Setup

Many central monitor setup features are identical to those of the bedside monitor.

**Refer to the following referenced sections for descriptions of these features:**

- Clock menu (refer to *Setting the Time and Date* on page 3-15)
- Screen saver (refer to *Activating the Screen Saver* on page 3-13)
- Date/Time (refer to *Setting the Time and Date* on page 3-15)
- QRS tones (refer to *Setting QRS Tones* on page 3-15)

## Selecting Parameters for Display

The SCREEN FORMAT key in the **Monitor Setup** menu enables you to assign remote parameters to specific display zones and to choose the color of those zones. The names displayed in the subnet and bed keys are assigned by your system administrator.

One to eight display zones can be viewed across the entire display. Split-view central monitors can accommodate up to 16 display zones, with zones 1 through 8 displayed on the left and zones 9 through 16 displayed on the right.

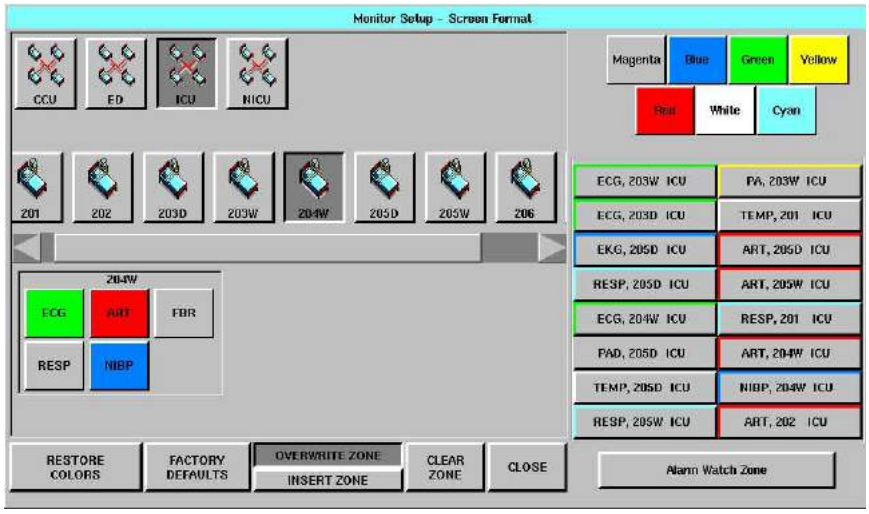



*Figure 4-2: Screen Format dialog box, split-view central monitor*

**To select remote parameters for display:**

- Touch MONITOR SETUP.
- Touch SCREEN FORMAT.
- Select a bed.

  -OR-
- Select a subnet and then a bed.
- Select the parameter(s) to be displayed.
- Select a zone.

**To assign color to a zone:**

- Touch MONITOR SETUP.
- Touch SCREEN FORMAT.
- Touch the desired color.
- Touch the zone to be colored.

**The other Screen Format (*Figure 4-2*) keys function as follows:**

- **RESTORE COLORS** — Restores the last stored color settings from memory.
- **FACTORY DEFAULTS** — Restores the factory-default color settings.
- **OVERWRITE ZONE** — Overwrites a zone that was previously assigned. Select the new parameter and then touch OVERWRITE ZONE to remove the previously assigned parameter channel from the display zone and replace it with the new parameter.
- **INSERT ZONE** — Inserts a new zone into a block of assigned zones. Touch INSERT ZONE, then touch the location where you wish to add a new zone. If a zone is inserted on top of an assigned zone, then the assigned zone and all other zones immediately adjacent to the assigned zone are pushed down by one zone, and the new zone is inserted above them. If this causes an assigned zone to disappear from the display, a warning message appears prompting you to complete or cancel the insert.
- **CLEAR ZONE** — Clears the zone assignment and returns that zone to an unassigned state. Touch CLEAR ZONE, then touch the zone from which you wish to remove an assignment. The zone key label is cleared.

## Data Communications Watch

***Note:***

*A system administrator with biomed level privileges controls the Data Communications Watch feature.*

The central monitor's Data Communications Watch (DCW) feature displays a Data Communications Interrupted (DCI) notice when its communication link with a bedside monitor is interrupted. This DCI notice replaces each channel that was lost due to the communication interruption. Possible causes of such interruptions include when the bedside monitor is powered OFF or is disconnected from power, a network failure occurs, or when other circumstances prevent communication from occurring.

The DCI notice includes the bed name, patient identification string, the parameter key of the lost channel, and keys labeled YES and NO (as shown in *Figure 4-3*). The time and date that communication was lost can be determined by touching the lost parameter's key and noting the message that appears at the bottom of the display.

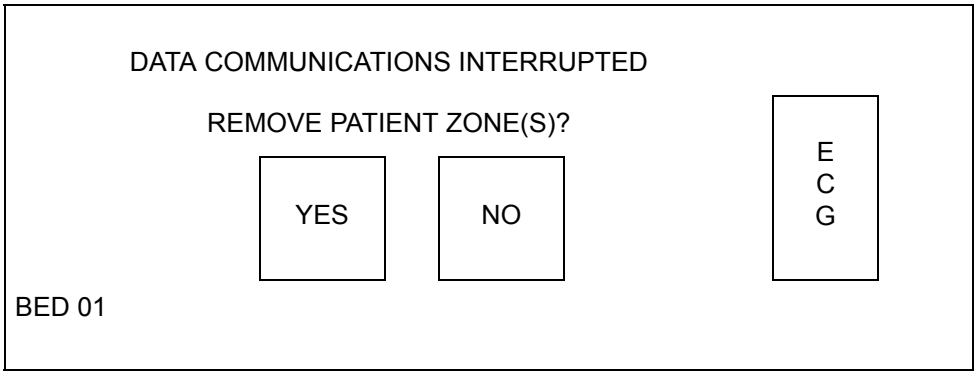



*Figure 4-3: DCI notification screen*

An optional low priority alarm occurs if the DCI alarm is enabled. When that alarm is enabled, the parameter key of the lost channel flashes and an alarm tone sounds.

The YES and NO keys control the central station's continued display of the lost channels as well as the optional DCI alarm. All of a bedside monitor's DCI notices are controlled by any of the YES and NO keys in its display zones.

Selecting YES removes every DCI notice for that bedside monitor from the central monitor's display and ends the DCI alarm. Selecting NO ends the DCI alarm without removing that bedside monitor's DCI notices from the display and disables the NO key.

Central monitors attempt to restore communication with the remote monitor, unless something else is assigned to that display zone. The patient data is automatically restored once communication is restored.

Your central monitor may be configured to watch for communication interruptions involving monitors for all patients, or only for monitors that have had patients admitted to them. Your system administrator controls this configuration option as well as the optional DCI alarm.

# Central Monitor Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Cannot assign color to a zone** | ■ Monitor may not be set up to allow you to assign colors. | ■ Contact your system administrator. |
| **Cannot assign a parameter to a zone** | ■ Zone may not have been cleared of previously assigned waveforms. | ■ Select CLEAR ZONE, then touch the zone in which to display the new parameter. Repeat the initial SCREEN FORMAT steps. |
| **Cannot access the clock menu** | ■ Clock may be in STOPWATCH or TIMER mode. | ■ Touch the clock/timer display, then touch PREVIOUS MENU to restore the clock. |
| **Cannot deselect ALARM WATCH** | ■ The central monitor is configured with Central Alarm Watch Manager to prevent de-selection of automatically alarm-watched beds. | ■ Contact your system administrator. |

# Dynamic Network Access (DNA)

## Directory of Keys




*Refer to Introduction* | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**SPECIAL FUNCTIONS (Central Monitor—SL3800)**

| ALARM WATCH | AW OFF | ALARM LIMIT REVIEW | REMOTE TRENDS/CALCS | DNA |
|---|---|---|---|---|

*Refer to Introduction*

**SPECIAL FUNCTIONS (Bedside Monitor—SL2600 and SL2800)**

| REMOTE VIEW | ALARM WATCH | RV/AW OFF | ALARM LIMIT REVIEW | LOCAL TRENDS/ CALCS | REMOTE TRENDS/CALCS | DATA LOGGER | DNA |
|---|---|---|---|---|---|---|---|

*Refer to Introduction* *Refer to Introduction*

# Dynamic Network Access (DNA)

## Contents

Overview . . . . . 3
Connection View . . . . . 5
Program Neighborhood View . . . . . 6

## Overview

The Dynamic Network Access™ (DNA™) is a Spacelabs Healthcare proprietary version of the Citrix ICA Client that provides the ability to connect and interact with the remote applications hosted on Citrix servers. DNA is available as a standard feature on Ultraview SL2800 and 2900 bedside monitors and as an optional feature on Ultraview SL2600 bedside monitors and Ultraview SL3800 and 3900 central monitors.

When using DNA on single-display monitor configurations (for example, SL2600, SL2800, and SL3800) the **DNA** application window is superimposed over the monitoring display window. A custom window manager maintains full integrity of all monitoring functions. In the event of a high-priority alarm, the **DNA** application window will be minimized and the monitoring display window will be presented. Audible and visual alarm indications will provide specific alarm information.

When using DNA on dual-display monitor configurations (for example, SL2900 and SL3900), the DNA application window is presented on a second display independent of the monitoring display window. As such, the DNA application window remains active throughout high-priority alarms.

The clinical user may only *connect* to a list of server locations or published applications. The list of server locations or available applications must be configured by the biomed technician or system administrator through the **Privileged Access** menu.

Your system administrator or other designated personnel must first set up communication between the Ultraview SL monitor and server locations and/or applications before DNA can be used. The accessible applications and servers are configurable. Refer to the *91370 Service Manual, P/N 070-1315-xx or the 91387 Service Manual, P/N 070-1159-xx,* for information on DNA configuration.

***Note:***

*Ensure that any computer or communications equipment connected to the network complies with applicable medical standards.*

**To access DNA:**

- Touch SPECIAL FUNCTIONS.
- Touch DNA.

## Accessing DNA

1 From the **Special Functions** menu, touch DNA.

2 The **DNA** window opens and displays either the **Connection View** or **Program Neighborhood View**.

What displays will depend on the configuration settings made at the biomed level.

- If DNA is configured to display a list of servers or connection definitions, then the **Connection View** displays with its list of selectable connections.
- If DNA is configured to display a list of published applications, then the **Program Neighborhood View** displays with its list of published applications.

When a tab view is open, the clinician may alternate between the **Connection View** and the **Program Neighborhood View**.

## DNA Application Window

The size and position of the **DNA** application window may vary. Its initial size and position is specified in the **DNA Setup** menu. Refer to the *91370 Service Manual, P/N 070-1315-xx or the 91387 Service Manual, P/N 070-1159-xx,* for information on DNA configuration. Once the **DNA** application window is displayed, it may be repositioned and resized. The monitor will retain the size and position until the next DNA session starts.

If the size of the **DNA** application window is smaller than the size required by the remote application, scroll bars will be displayed that allow the user to move around the full application window.

***Note:***

*When using DNA on a single-display monitor configuration, the **DNA** application window is automatically minimized in the event of a high-priority alarm condition.*

If a connection is made to a server, the window may be resized to what is specified in the connection setup.

# Connection View

The **Connection View** displays a list of configured static connections that allow access to Citrix servers on the network. Connections are listed by **Description** and **Server Address**.

***Note:***

*A list of accessible servers must be previously configured through the **Privileged Access** menu.*

## Connecting To a Server

1 Double-click an item in the list.

2 Click or touch an item to select it, and then click or touch **Connect** (refer to *Figure 5-1* on page 5-5).

***Note:***

*Selecting an item in the list enables the **Connect** key.*

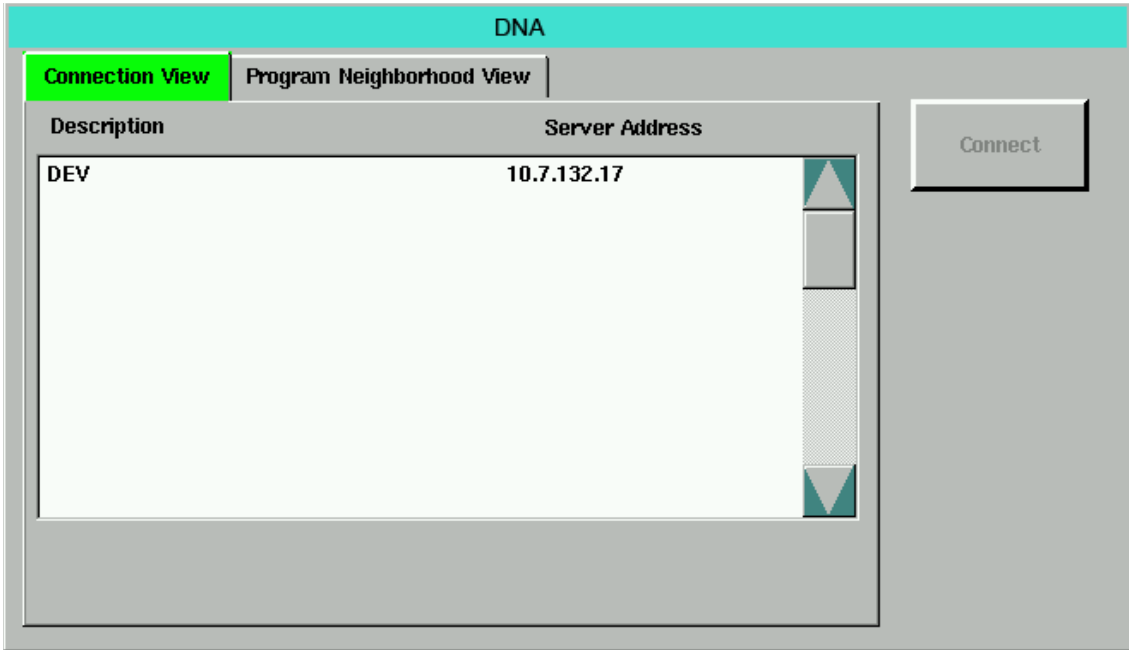



*Figure 5-1: Connection View*

# Program Neighborhood View

The **Program Neighborhood View** primarily displays a list of published applications with a dynamic list acquired from a Citrix server or servers (refer to *Figure 5-2* on page 5-6).

***Note:***

*A list of accessible servers must be previously configured through the **Privileged Access** menu.*

## Connecting To a Published Application

Login credentials are required to access published applications from the **Program Neighborhood View**.

1 Touch **Program Neighborhood View**.

**Program Neighborhood View** initially opens with a blank scroll window (refer to *Figure 5-2*).

***Note:***

*You must log in to view and connect to a list of published applications.*

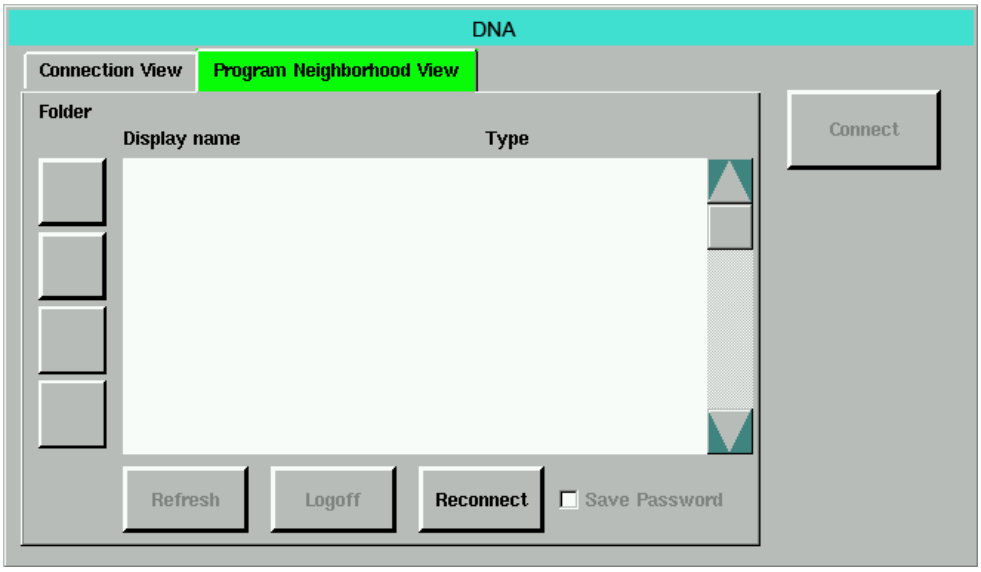



*Figure 5-2: Program Neighborhood View before login*

2 When the **Login** window opens, enter **Username**, **Password**, and **Domain** in the entry fields (refer to *Figure 5-3*).

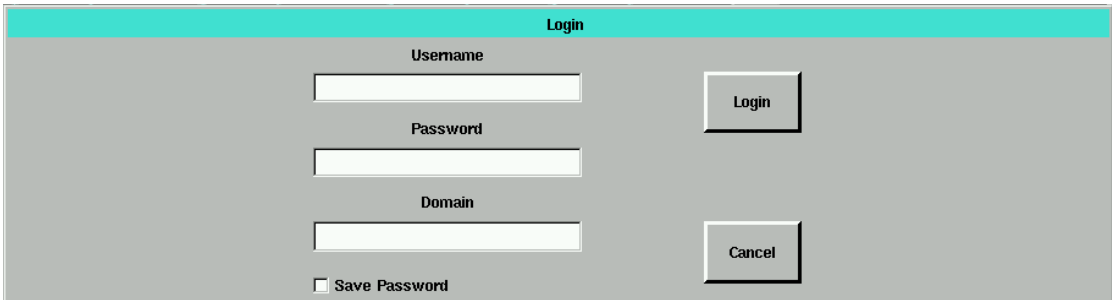



*Figure 5-3: Login credentials window*

3 Select the **Save Password** check box and touch **Login**.

- Selecting **Save Password** allows you to launch multiple published applications without having to re-enter your login credentials.
- To save a password, you must select the **Save Password** check box on the **Login** window.

***Note:***

- *Selecting the **Save Password** check box on the **Login** window automatically selects the **Save Password** check box in **Program Neighborhood View** (Figure 5-4 on page 5-8).*
- *You may de-select the **Save Password** check box in **Program Neighborhood View** to "un-save" the password of a user who is done launching published applications. This allows other users to log in to and utilize the monitor.*

-OR-

4 Touch **Login** *without* selecting the **Save Password** check box.

***Note:***

*If you choose to not select **Save Password**, you must log in every time you attempt to connect to any other applications through the **Program Neighborhood View**.*

-OR-

5 Touch **Cancel** to exit the **Login** window and return to the **Program Neighborhood View**.

After logging in, the **Program Neighborhood View** is populated with a list of published applications (*Figure 5-4*). Up to 128 items may be listed in the **Program Neighborhood View**.

***Note:***

*Selecting an item in the list enables the **Connect** key.*

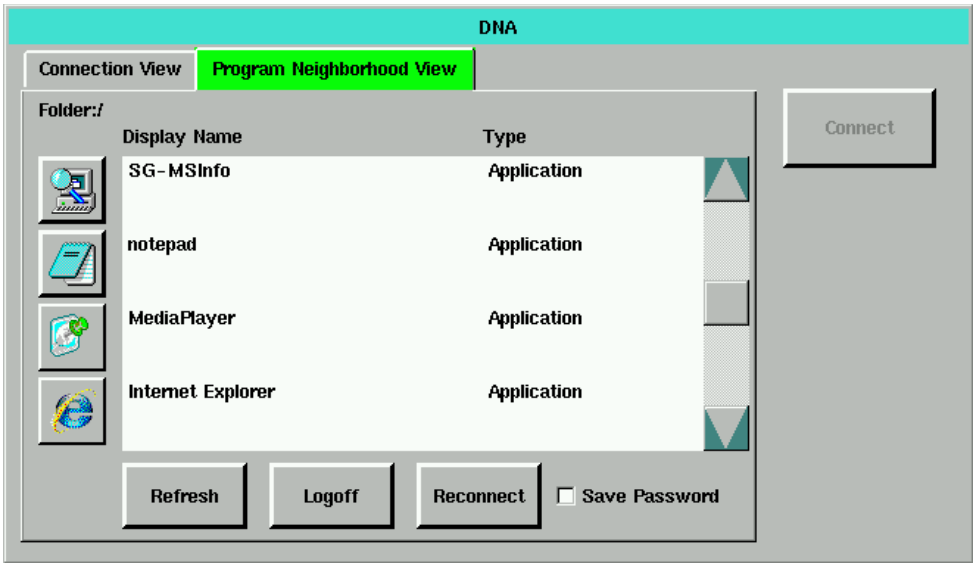



*Figure 5-4: Program Neighborhood View*

6 Scroll through the **Display Name/Type** list to select an application. Three types may be listed in this window:

- *Applications or server desktops*
  - Desktops are indicated by a server address.
  - Only one application at a time may be utilized.
- *Content (text files, Word documents, etc.)*

  These file types will execute specific applications. Each file type is used to find the appropriate published application to run.
- *Folders (a one-level subdirectory represented by a down arrow ). Up to five applications may be housed in each folder.*
  - Selecting the down arrow displays the contents of the folder.
  - When the folder is open, an up arrow appears as the first entry. The first entry name displays as "**..**".
  - Touch the up arrow to return to the top level application display.

There are three ways to launch a published application.

7 Double-click a **Display Name** entry.

-OR-

8 Click or touch the **Display Name** entry to select it, then click or touch **Connect**.

-OR-

9 Click or touch the icon located to the left of the **Display Name** entry.

The icons to the left allow easy startup of the applications. They scroll in sync with the window of listed items on the right.

10 Touch **Reconnect** to attempt to reconnect to a disconnected session.

11 Touch **Refresh** to query the server for a fresh list of applications.

12 Touch **Logoff** to log out from the **Program Neighborhood View** window.

***Note:***

*Touching **Logoff** requires you to log back in to the **Program Neighborhood View** if you have not selected **Save Password**. **Connection View** is still accessible.*

13 Click or touch the minimize icon in the upper right corner of the **DNA** application window (refer to *Figure 5-5*) to minimize the **DNA** application window, but leave the DNA session running.

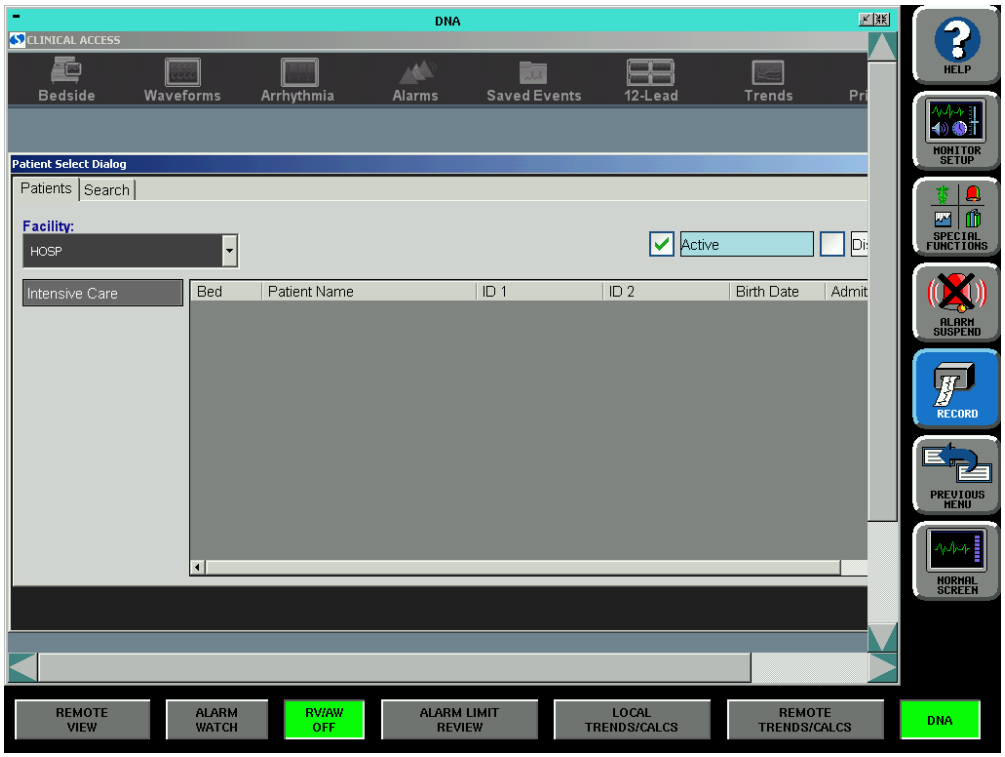



*Figure 5-5: DNA application window with open application*

14 From the **Special Functions** menu, touch the DNA key on the monitoring display window to restore the minimized **DNA** application window.

15 Click or touch the logoff icon  (refer to *Figure 5-5*) to close an open DNA application.

If you touch the DNA key during a DNA session when the **DNA** application window is *not* minimized, a small logoff window displays (refer to *Figure 5-6*).

-OR-

If you click or touch the logoff icon, the **Logoff** window displays (refer to *Figure 5-6*).

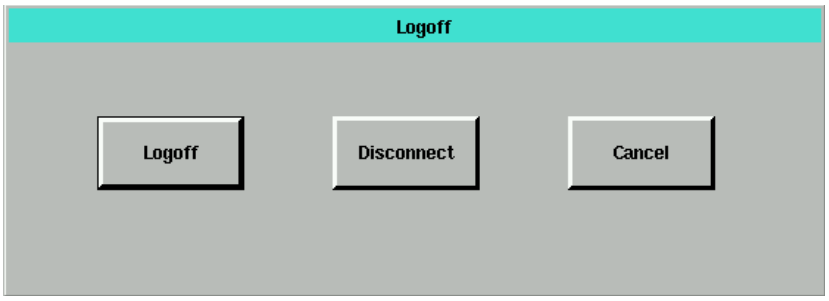



*Figure 5-6: Logoff window*

16 Touch **Logoff** to terminate the application and disconnect the current DNA session.

17 Touch **Disconnect** to disconnect the current DNA session, but leave the application running.

18 Touch **Cancel** to remain connected to the current DNA session.

***Note:***

*Once an application is launched, the DNA key will not allow the launching of another application or desktop until the existing session has terminated. To run multiple applications simultaneously, you must open a desktop and launch the applications from within the desktop session.*

# Perioperative

## Directory of Keys




*Refer to Introduction*










*Refer to Alarms*




*Refer to Printing*







*Refer to Introduction*

**MONITOR SETUP**

| TONES | ADMIT/ DISCHARGE | PRIMARY CONFIG. | SECONDARY CONFIG. | RECORDER CONFIG. | PRIVILEGED ACCESS |
|---|---|---|---|---|---|
| *Refer to Alarms* | *Refer to Admit/Discharge* | *Option -D only* | *Option -D* SL2600/ SL2700/SL2800 monitors only | *Refer to Printing* | *Refer to Bedside Monitors* |

**MONITOR CONFIGURATION - SECONDARY MONITOR**

| MINOR GRATICULE | PARAMETER CONFIG | CLOCK | |
|---|---|---|---|
| | | ON | OFF |

**MINOR GRATICULE - *N* Divisions**

| MINOR GRAT | | ↓ | ↑ |
|---|---|---|---|
| ON | OFF | | |

**MONITOR CONFIGURATION - PRIMARY MONITOR**

| ENERGY SAVING MODE | | OR | SCREEN BRIGHTNESS | | MINOR GRATICULE | PARAMETER CONFIG | CLOCK | | ALARM LIGHT | | ACTIVATE SCREEN SAVER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ON | OFF | | NORMAL | DIM | | | ON | OFF | ON | OFF | |
| *DC Power SL2400/SL2600 only Refer to Bedside Monitors* | | | *AC Power SL2400/SL2600 only Refer to Bedside Monitors* | | *Refer to Bedside Monitors* | | *Refer to Bedside Monitors* | | *SL2400/ SL2600 only Refer to Bedside Monitors* | | *Refer to Bedside Monitors* |

# Perioperative

## Contents

Overview . . . 3
Identifying Perioperative Functions . . . 3
Start Case/End Case . . . 4
User Preference Configurations . . . 8
Secondary Display . . . 6
Perioperative Troubleshooting Guide . . . 13

## Overview

Perioperative features extend the functionality of Spacelabs Healthcare monitors and modules to the operating room. Perioperative features include START CASE/END CASE keys on the monitor; a configurable secondary display; and extended user-configurable display preferences.

## Identifying Perioperative Functions

If your monitor was purchased with the Perioperative option, additional keys identifying those perioperative functions appear in the **Monitor Setup** menu and on the monitor's menu line keys. Perioperative features include:

START CASE and END CASE keys — These keys (refer to *Figure 6-1*) control the operation of the monitor and modules by case, and silence audible alarms when the alarms are not needed. However, visual alarm indicators will continue to display upon END CASE, unless ALARM SUSPEND is pressed.

Remote Configurable Display — A secondary display that is controlled from the monitor's **Monitor Setup** menu, using the SECONDARY CONFIG. key, and from the menu line, using the SECONDARY CONTROL key (refer to *Figure 6-1*). The parameter attributes of the secondary display can be configured differently than the primary display.

User Preference Configurations — Parameter display configurability is extended by supporting named sets of configurations for the primary and secondary displays. Up to five separate configurations can be set for individual users or case types.

# Start Case/End Case

When enabled, the monitor displays a key labeled START CASE or END CASE with the menu keys along the bottom of the monitor's display. The key will toggle to the opposite state when touched and confirmed.




*Figure 6-1: START CASE/END CASE and SECONDARY CONTROL menu line keys*

### Starting a Case

Touch START CASE to start a patient case. The **Keep Settings?** dialog box displays. The KEEP SETTINGS key allows you to keep all user-configured parameter module settings.

The DEFAULT SETTINGS key restores the parameter modules to the default settings specified in Module Configuration Manager. For more information, refer to the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx) or contact your hospital system administrator.

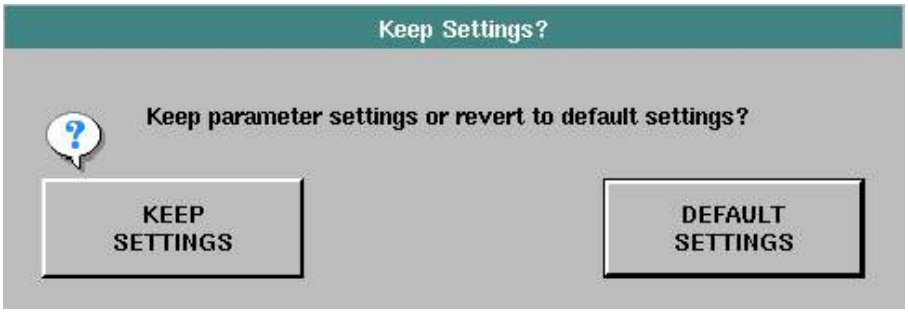



*Figure 6-2: Keep Settings dialog box*

Touching KEEP SETTINGS or DEFAULT SETTINGS will open a **Purge Patient Data?** confirmation window, if the monitor is configured to query the user (contact your system administrator for details). Touching YES will erase all patient data. Touching NO will retain patient demographic data.

**To start a case:**

- Touch START CASE.

**-OR-**

- Touch KEEP SETTINGS.
- Touch YES to purge data, or touch NO to keep patient data (if enabled).

**-OR-**

- Touch DEFAULT SETTINGS.
- Touch YES to purge data, or touch NO to keep patient data (if enabled).

***Note:***

*If you accidentally touch START CASE, you can touch NORMAL SCREEN to prevent the case from starting.*

## Ending a Case

You can end a case by touching the END CASE key. The **End case?** confirmation dialog box displays. Touch END CASE in the **End Case?** dialog box to return to the monitoring window. The END CASE button toggles to START CASE.

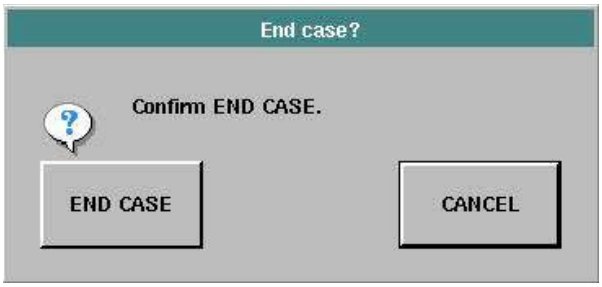



*Figure 6-3: End case confirmation dialog*

When a case is ended, alarm tones are OFF, but alarm monitoring continues, and visual indicators of alarms continue to display. Remote alarm notification is prevented.

### *Warning:*

- ***Ensure that the case is complete before touching END CASE. Before ending the case, ensure that the patient is being monitored by other equipment or by a dedicated caregiver for a limited time (such as when a patient is being transferred to a transport monitor).***
- ***After a case is ended, ALARM SUSPEND should only be used if no patient is connected to the monitor.***

If you touch the ALARM SUSPEND key when the case is ended, visual and audible alarms will not re-initialize. Touch ALARM SUSPEND again or touch START CASE to re-initialize visual alarms. Individual parameters may treat an end case differently. Refer to the appropriate parameter chapter for descriptions of end case functionality, if applicable.

**To end a case:**

- Touch END CASE.
- Touch END CASE on the **End Case?** dialog box.

# Secondary Display

The secondary display is configurable and can display different parameter information than is shown on the primary display. The presentation of these parameters on the secondary display is also configurable.

The primary monitor is used to configure the secondary display. Refer to *User Preference Configurations* on page 6-8 for information on configuring parameter priorities and colors for the secondary display.

***Note:***

- *Support for the secondary display is not available for the SL2200 and SL2400 monitors.*
- *The secondary display has no functional keys or audio capabilities.*
- *When using the integrated Remote Configurable Display, option C, which is available for the SL2700 and SL2800 monitors, the secondary display provides a real-time representation of the waveform data. Procedures requiring real-time waveform data can be performed by viewing either the primary or secondary display.*

***Warning:***

***When using the 91388 Remote Display Controller, the secondary display provides a time-delayed (approximately 2 to 3 seconds) representation of the waveform data. Procedures requiring real-time waveform data must be performed by viewing the primary display.***

## Secondary Control

The SECONDARY CONTROL menu key (refer to *Figure 6-1* on page 6-4) allows access to display functions for the secondary display, without navigating through the MONITOR SETUP menu structure.

Touching the SECONDARY CONTROL key opens the **Secondary Display** dialog box.

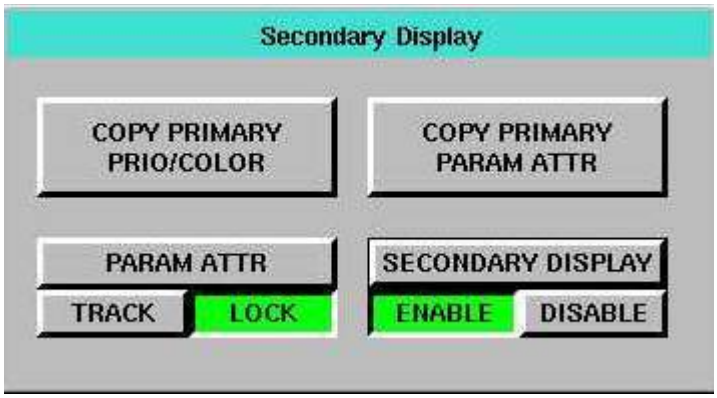



*Figure 6-4: Secondary Display dialog box*

### SECONDARY DISPLAY ENABLE/DISABLE

Touching the SECONDARY DISPLAY ENABLE/DISABLE key controls the state of the secondary display.

**To enable or disable the secondary display:**

- Touch the SECONDARY CONTROL.
- Touch SECONDARY DISPLAY ENABLE or DISABLE.

Refer to *Secondary Display Configuration* on page 6-11 for descriptions of the COPY PRIMARY PRIO/ COLOR, COPY PRIMARY PARAM ATTR, and PARAM ATTR TRACK/LOCK keys.

## Scaled Displays

The secondary display can display up to four scaled pressures simultaneously (refer to *Pressure* on page 20-3). Monitors optionally display minor graticule lines that can be adjusted. Minor graticules are small, dashed line segments that appear between the full-scale graticule lines.

Minor graticules can be independently adjusted on the primary display and the secondary display. Refer to *Using Scaled Displays* on page 3-12 for information about adjusting the minor graticule on the primary display.

**To adjust the scaled display on a secondary display:**

- Touch MONITOR SETUP.
- Touch SECONDARY CONFIG.
- Touch MINOR GRATICULE.
- Select MINOR GRAT ON/OFF.
- Use the arrow keys to adjust.

## System Clock

A system clock can be continually displayed in the lower right corner on the secondary display.

**To access the clock menu for the secondary display:**

- Touch MONITOR SETUP.
- Touch SECONDARY CONFIG.
- Touch CLOCK ON/OFF.

# User Preference Configurations

The PARAMETER CONFIG. keys, located under the **Monitor Setup** menu PRIMARY CONFIG. and SECONDARY CONFIG. keys, allow you to set parameter priorities and colors on the primary and secondary displays.

## Setting Priorities and Colors

Each parameter displays in the order of its assigned priority. The highest priority appears at the top of the display, with the number 1. The **Parameter Config.** (refer to *Figure 6-5*) window enables you to change the priority and color of parameters.

Refer to *Table 1* on page 3-11 for a list of default priorities and colors for each parameter.

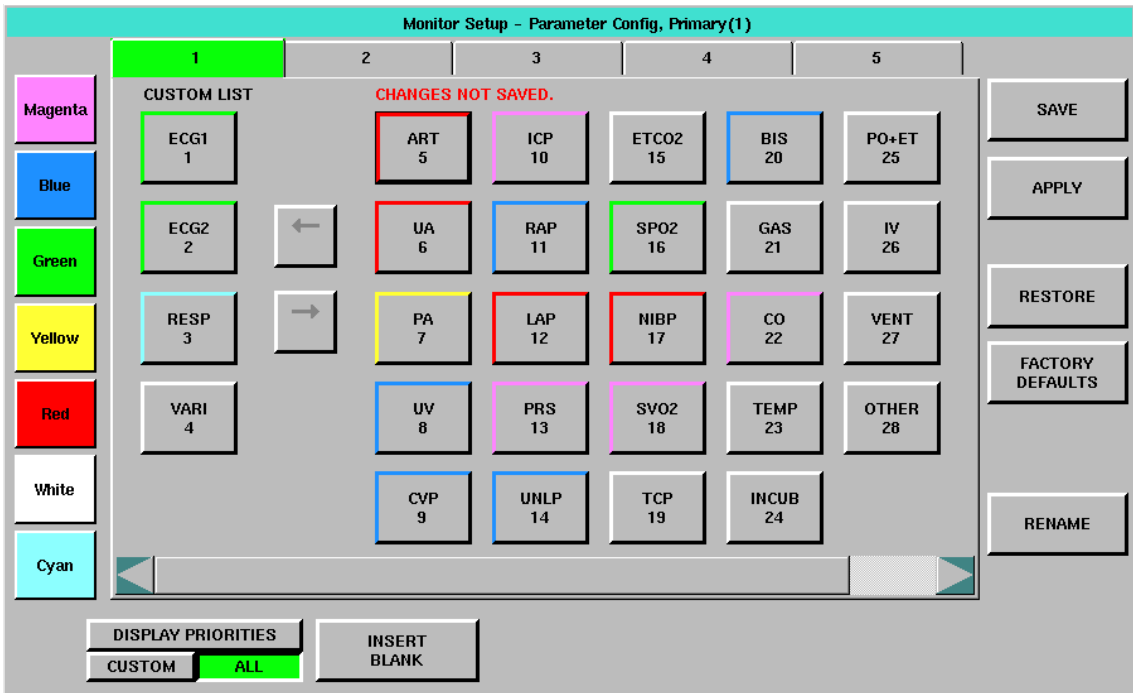



Figure 6-5: **Parameter Config.** window, primary display

### DISPLAY PRIORITIES

The DISPLAY PRIORITIES key lists all the current bed's supported parameters (ALL), or a selected subset of parameters (CUSTOM). Touching ALL will display all the monitor's supported parameters.

Touching CUSTOM displays only the subset of parameters the user has selected, such as the parameters used most frequently. You can configure up to five sets, which correspond to tabs **1** through **5** in the **Parameter Config.** window.

Use the arrows keys to move the parameters between the CUSTOM LIST and the full parameters list. Or, if parameters are already listed under CUSTOM LIST, touch a parameter from the full list, and then touch the desired position under CUSTOM LIST. The new parameter replaces the position of the previous parameter under CUSTOM LIST.

Using the arrows keys to move the parameters from the full list to CUSTOM LIST places the parameter in the lowest position. To change the order of a parameter, touch that parameter, then touch the position you wish to place the parameter.

***Note:***

*You can configure parameter priorities and positions without the parameter module present.*

### INSERT BLANK

The INSERT BLANK keys enable you to insert a space above or below a parameter. Blanks can be inserted by touching the blank key and then inserting the blank key space into the desired location. After selecting a blank, touch APPLY or SAVE. A blank zone then occupies the corresponding position on the display.

To remove a blank key, touch the blank key then touch the right arrow to move it out of the CUSTOM LIST.

### SAVE

The SAVE key saves and applies any changes made to the priority and color settings. CHANGES NOT SAVED displays in the **Parameter Config.** window until you save the settings. If you touch another tab without saving changes, the previous tabs displays in red.

To retain configuration changes after the monitor is powered OFF, you must select SAVE.

### APPLY

The APPLY key applies any changes made to the priority and color settings of the current display, but does not save those changes when the monitor is powered OFF. Changes made to a configuration take effect after touching APPLY.

To retain configuration changes after the monitor is powered OFF, you must select SAVE.

**To change the primary display parameter priorities or colors:**

- Touch MONITOR SETUP.
- Touch PRIMARY CONFIG.
- Touch PARAMETER CONFIG.
- Touch one of the tabs along the top of the **Monitor Setup - Parameter Config.**, if necessary.
- Select a parameter.
- Touch the left arrow to move the *first* parameter into the CUSTOM LIST.

  -OR-
- Select the destination priority by touching the position in the CUSTOM LIST column (all subsequent parameters).
- Select a color.
- Select the parameter key to be colored (the key and waveform will appear in the chosen color).
- Touch SAVE to store the local color and priority settings, or touch APPLY to only display the settings.

## RESTORE

The RESTORE key discards any changes made to the settings that have not been saved. Touching RESTORE, then touching APPLY, reverts to the last-saved settings.

## FACTORY DEFAULTS

The FACTORY DEFAULTS key resets the factory-default priority and color settings, but does not save them. You can continue to make configuration changes to the display.

## RENAME

The RENAME key opens an on-screen keyboard (refer to *Figure 6-6* on page 6-10). You can rename the active tab with a name of up to 15 characters on SL2800, SL2700, and SL2600 monitors, and up to 8 characters on an SL2400 monitor.

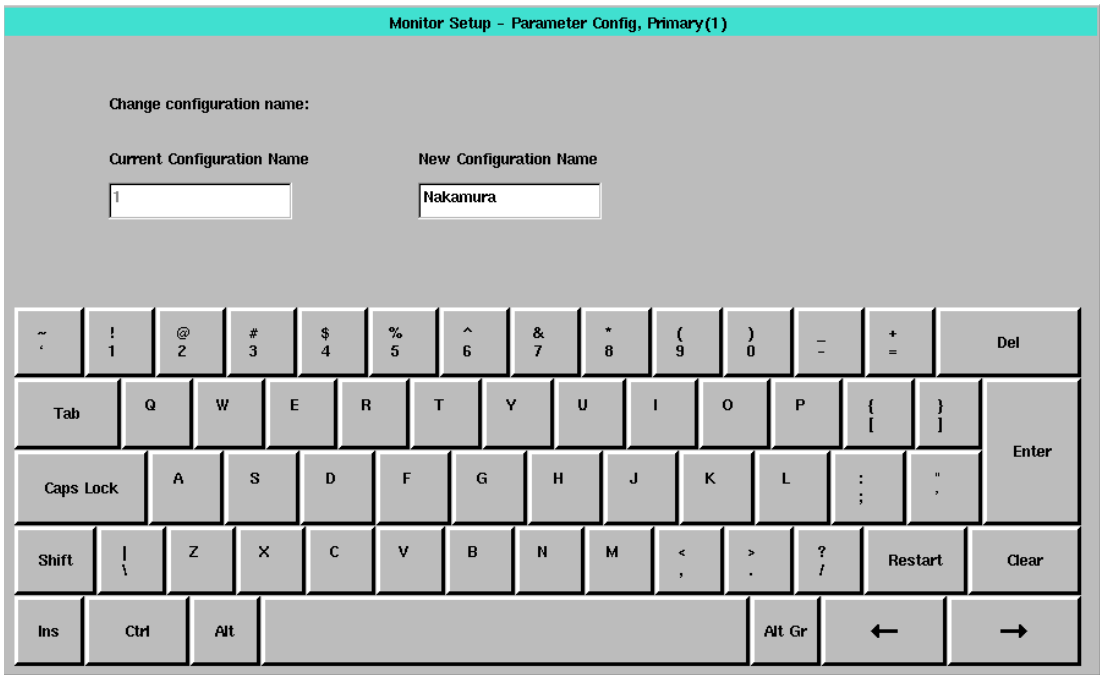



*Figure 6-6: Renaming a tab*

**To rename a Parameter Config. window tab:**

- Touch MONITOR SETUP.
- Touch PRIMARY CONFIG. or SECONDARY CONFIG.
- Touch PARAMETER CONFIG.
- Touch a tab (1 through 5).
- Touch RENAME.
- Enter the new name.
- Touch Enter.

## Secondary Display Configuration

The secondary **Parameter Config.** window includes several additional keys.

***Note:***

*The secondary display can only be configured to display information for parameters that are being monitored at the primary monitor.*

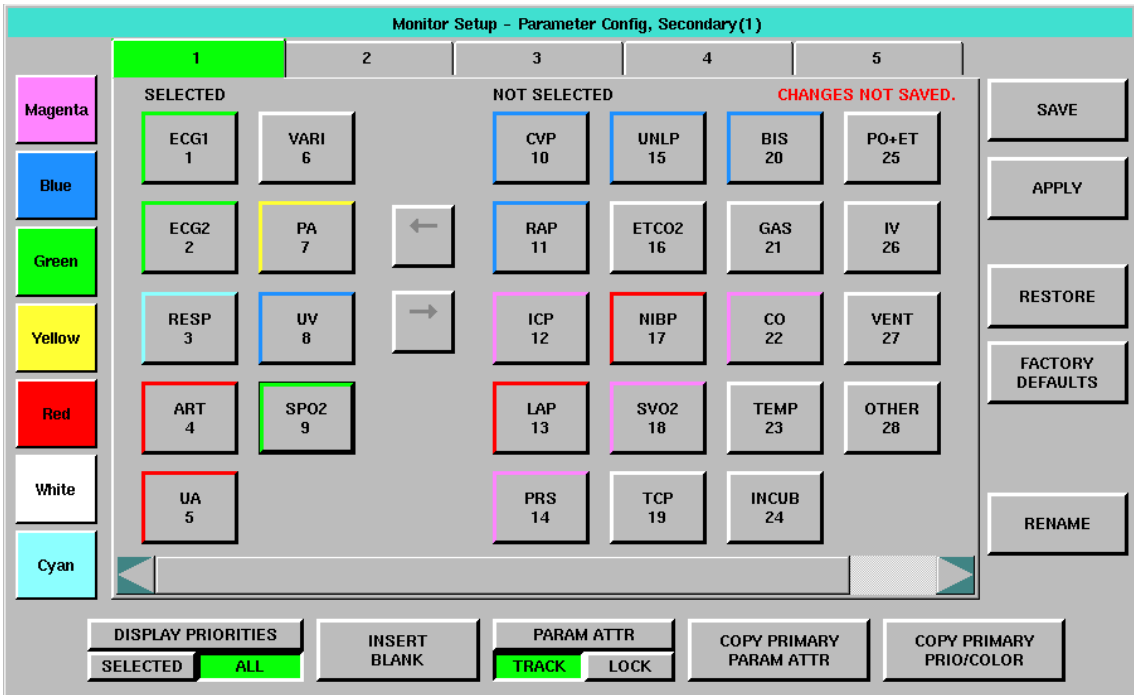



*Figure 6-7:* **Parameter Config.** *window, secondary display*

### PARAM ATTR TRACK/LOCK

Selecting PARAM ATTR TRACK or PARAM ATTR LOCK determines whether parameter attribute changes made on the primary display are also made on the secondary display. The default setting is PARAM ATTR TRACK.

The parameter attributes affected by PARAM ATTR TRACK/LOCK and COPY PRIMARY PARAM ATTR are waveform size, sweep speed, and invasive pressure scales.

When PARAM ATTR TRACK is selected, all changes made to the primary display parameter attributes are also made on the secondary display. When PARAM ATTR LOCK is selected, the secondary display maintains its parameter settings, and any display changes made to the primary display do not affect the secondary display.

Selecting PARAM ATTR TRACK does not immediately copy the primary displays parameter attribute settings to the secondary display. Each setting is copied to the secondary when the next valid change is made to that setting. You can use COPY PRIMARY PARAM ATTR to copy all display attributes from the primary to the secondary display (refer to *COPY PRIMARY PARAM ATTR* on page 6-12).

***Note:***

- *Some multiple waveform parameter views such as ECG split-view and full-view displays, Multigas, and BISx cannot be locked. Any changes to a parameter's multiple waveform view are immediately visible on the secondary display, even if PARAM ATTR LOCK is selected.*
- *Locking does not apply to parameters such as Varitrend, which "plot" data on the display. In these cases the parameters always update on both the primary and secondary displays, even if PARAM ATTR LOCK is selected.*
- *DNA windows cannot be displayed on the secondary display.*

### COPY PRIMARY PRIO/COLOR

Selecting this key copies the parameter color and priority settings of the primary display to the secondary display.

The secondary **Parameter Config.** window updates immediately, and the secondary display updates when you select SAVE.

### COPY PRIMARY PARAM ATTR

Selecting this key copies the primary display's parameter attributes, such as sweep speeds or waveform sizes, to the secondary display. The secondary display updates immediately. Refer to *PARAM ATTR TRACK/LOCK* on page 6-11 for more information.

**To change the secondary display parameter priorities or colors:**

- Touch MONITOR SETUP.
- Touch SECONDARY CONFIG.
- Touch PARAMETER CONFIG.
- Touch a tab.
- Select a parameter.
- Select the destination priority.
- Select a color.
- Select the parameter key to be colored (the key and waveform will appear in the chosen color after touching APPLY).
- Touch SAVE to store local color and priority settings, or touch APPLY to only display the settings.

***Note:***

*The parameter will not appear on the secondary display unless it is selected and appears in the SELECTED column.*

# Perioperative Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No parameter output to secondary display** | ■ There is no communication between the monitor and the secondary display. | ■ If using a 91388 Remote Display Controller: Refer to the *Remote Display Controller Service Manual* (P/N 070-1330-xx) for setup and configuration information.<br>■ If using the Remote Configurable Display, option C: Ensure the second DVI output is connected to the secondary display. If the display cable length exceeds 9 feet, third-party video repeaters must be used. Refer to the video repeater installation information for configuration and limitations. |
| **Changed parameter priority or colors are lost** | ■ The SAVE key was not touched after the selection was made. | ■ Touch the SAVE key to make changes permanent. |
| **Secondary display is too dim or has poor contrast** | ■ The secondary display is not optimized for brightness or contrast. | ■ Refer to the display user's guide for information on adjusting the display. |
| **The secondary display output is distorted or shows static or "noise"** | ■ The display cable is too long, or it is routed too close to a source of interference. | ■ If using a 91388 Remote Display Controller: Refer to the *Remote Display Controller Service Manual* (P/N 070-1330-xx) for proper cable lengths and positioning.<br>■ If using the Remote Configurable Display, option C, and the display cable length exceeds 9 feet, third-party video repeaters must be used. Refer to the video repeater installation information for configuration and limitations. |

# Alarms

## Directory of Keys

### Adjusting Alarm Tones




*Refer to Introduction* | *Refer to page 7-3* | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**MONITOR SETUP**

TONES

MONITOR CONFIG

**MONITOR CONFIGURATION**

| ALARM LIGHT | |
|---|---|
| ON | OFF |

*SL2400/SL2600 only*

**MONITOR SETUP - Select type of tone to change**

LOCAL ALARMS | REMOTE ALARMS | ALARM WATCH | KEY TONE

**MONITOR SETUP - LOCAL ALARM TONE**

| TONE | |
|---|---|
| ON | OFF |

VOLUME ↑

VOLUME ↓

# Setting up Automatic Alarm Recordings




*Refer to Introduction* | | *Refer to page 7-3* | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**MONITOR SETUP**

RECORDER CONFIG.

**RECORDER CONFIGURATION**

RECORDING DURATION | ALARM PARAMS | RECORDING DESTINATION

**Number of recorder channels**

1 | 2 | 4 | VITALS SETUP

*Only appear if printer is present*
**4 channels supported by 90469 only*

*SL2400/ SL2600 only*

**Alarm Recordings to**

THIS MONITOR | NETWORK | BOTH

**Other Recordings to**

THIS MONITOR | NETWORK

*Central*

*Bedside*

**Select Bed**

BED X ...

**Select parameters that require alarm recordings from BED X**

| ECG | | RESP | | ... | MORE |
|---|---|---|---|---|---|
| ON | OFF | ON | OFF | | |

**Select duration for recordings initiated from this monitor**

12 SEC | 20 SEC

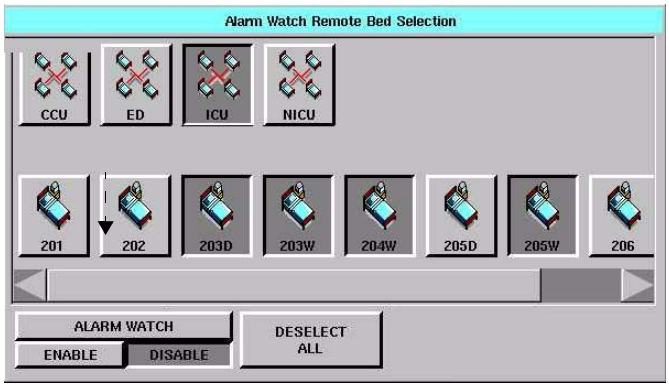
## Setting up Alarm Watch




*Refer to Introduction* *Refer to Alarms* *Refer to Printing* *Refer to Introduction*

**SPECIAL FUNCTIONS**

ALARM WATCH



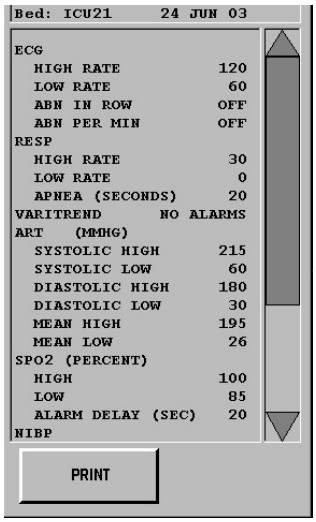

## Reviewing and Printing Alarm Settings (Alarm Limit Review)




*Refer to Introduction* *Refer to Alarms* *Refer to Printing* *Refer to Introduction*

**SPECIAL FUNCTIONS**

ALARM LIMIT REVIEW



# Alarms

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## Overview

**This chapter describes the following:**

- Setting alarm limits
- Setting alarm tones
- Silencing and suspending alarms
- Controlling the SL2400/SL2600 monitor's embedded alarm light
- Using the Alarm Watch feature
- Specifying parameters for automatic alarm recordings

***Note:***

*The bedside monitor is the primary monitoring and alarming device for Spacelabs-monitored parameters.*

When a parameter value on a bedside monitor exceeds an alarm limit, that monitor initiates an alarm. User notification of an alarm has five possible characteristics: visual, audible (tone), recorded, alarm relay, and alarm watch. The alarm's severity defines which of these characteristics is used for that particular alarm.

Higher-priority alarms relate to changes in the patient's condition. Lower-priority alarms typically relate to changes in signal quality. Higher-priority alarms always override lower-priority alarms.

***Warning:***

- ***Alarm conditions for which you want to be alerted must be set to ON or enabled at the location where you want to be alerted — either bedside or central. You can enable them from the local bedside monitor, remote bedside monitor, or central monitor.***
- ***To protect the patient's safety, do not silence, suspend, or disable audible alarms without providing continuous, direct observation of the patient.***
- ***Ensure high alarm limits and low alarm limits are appropriate for the age and condition of the patient being monitored.***

- ***Custom alarm settings are not maintained beyond the battery capacity. These durations are:***
  - ***91387 monitor — 3 minutes***
  - ***91367, 91369, 91370 monitors — up to 2.5 to 4 hours (depending on battery charge status)***

**Caution:**

- **Verify alarm settings on the monitor once during each shift and upon each patient admission to ensure that the alarm settings are appropriate for the patient being monitored.**
- **Verify alarm settings are appropriate for the patient being monitored, if the default settings are applied.**

***Note:***

- *Within 1 second, the network is notified of an alarm condition.*
- *Central station alarms will be displayed within 1 second of a bedside alarm condition.*
- *Dependent on configuration of the alarm rotation and if the monitor already has a parameter up on the alarming monitor, time to display a remote alarm can range from 1 second (alarm watch zone available) to 6 minutes (maximum alarm rotation time).*

A majority of physiological alarms default to high- and medium-priority alarms, and most technical alarms default to low-priority alarms. For patient safety, a few technical alarms (such as ECG's LEADS OFF alarm) default to medium-priority alarms. The Module Configuration Manager enables you to adjust these alarms. Refer to the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx).

**Two factors affect how physiological parameters initiate and terminate alarms:**

- how each physiological parameter is displayed, and
- how each physiological parameter initializes alarms.

### How Physiological Parameters are Displayed

Some parameters automatically appear and disappear from the monitor display, depending on whether their sensors are connected or disconnected. These parameters include $SpO_2$, Temperature, Invasive Pressure, and Cardiac Output.

Other parameters, such as ECG and NIBP, are continuously displayed regardless of connection status.

### How Physiological Parameters Initialize Alarms

Alarm processing for continually acquired parameters (e.g., ECG, $SpO_2$, Invasive Pressure) normally begins after that parameter detects a valid patient connection. It then initiates data analysis. Refer to *Learning and Relearning* on page 11-6 for more information.

Alarm processing for episodically acquired parameters (e.g., NIBP) begins after the first successful reading.

Technical alarms for all parameters normally end when parameter alarms are set to OFF. Physiological and technical alarms for parameters such as $SpO_2$, Temperature, and Invasive Pressure also end automatically when those parameters disappear from the monitor display (because their sensor is no longer connected).

# Default Alarm Limits

Default alarm limit settings are activated under any of the conditions listed below. You can modify these settings to meet your own protocols.

- The monitor is powered ON.
- A module is inserted.
- A parameter is enabled.

**Caution:**

**Verify alarm limits settings are appropriate for the patient being monitored, if the default alarm limits settings are selected.**

***Note:***

*To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

# Setting Alarm Limits

A parameter's **Alarm Limits** menu allows you to enable and change alarm limits for that parameter. The following Quickstart lists the basic procedure used to adjust high or low alarm limits for a parameter. For details concerning setting or adjusting alarm limits for a specific parameter, refer to the *Alarms* section of the appropriate parameter chapter in this manual.

**To set alarm limits:**

- Touch a parameter key (ECG, TEMP, etc.).
- Touch ALARM LIMITS.
- Ensure ALARMS are set to ON.
- Select HIGH = or LOW =.
- Use the arrow keys to adjust.

# Identifying Alarm Levels

Alarm conditions are visually and audibly prioritized as high, medium, or low.

***Note:***

- *The SL2400/SL2600 monitor's embedded alarm light, if enabled, flashes red for high priority alarms and flashes yellow (two different flash rates) for medium and low priority alarms.*
- *Due to display constraints, some parameters may not be visible on the monitor display. Should an alarm that is associated with one of these parameters occur, the monitor provides an audible alarm notification and an alarm violation message is displayed above the menu keys. For additional information about the alarm condition, touch the MORE key and any flashing parameter key.*
- *Alarm priorities are set using the Module Configuration Manager. Refer to the Module Configuration Manager System Administration Guide (P/N 070-1245-xx) for more information.*

*Table 1: Bedside Alarms*

| Priority | Tone Type* | Tone Duration | 91369/91370 | | 91367/91369/91370/91387 | |
|---|---|---|---|---|---|---|
| | | | Visual | Flash Rates | Visual | Flash Rates |
| **High** | Two bursts of five tones every 15 seconds, or continuous tone. | Until the alarm condition is resolved, the alarm is suspended, or the tone is reset. | Flashing embedded nurse alert; message appears in red. | 312 ms ON / OFF | Flashing parameter key; message appears in red. | 500 ms ON / OFF |
| **Medium** | Burst of three tones every 30 seconds, or intermittent tone (one second ON, one second OFF). | Until the alarm condition is resolved, the alarm is suspended, or the tone is reset. | Flashing embedded nurse alert; message appears in yellow. | 312 ms ON / OFF | Flashing parameter key; message appears in yellow. | 500 ms ON / OFF |
| **Low** | One tone every 30 seconds, or intermittent tone (one second ON, four seconds OFF). | Until the alarm condition is resolved, the alarm is suspended, or the tone is reset. | Flashing embedded nurse alert; message appears in yellow. | 312 ms ON 687 ms OFF | Flashing parameter key; message appears in yellow. | 500 ms ON / OFF |

* *The repetition rate for the High, Medium, and Low alarm tones can be adjusted by your system administrator.*

***Warning:***

***Alarm Watch and Remote View Alarms will generate a single tone, one time only, at a bedside monitor, and the tone will not be repeated, regardless of how long the alarm condition exists.***

*Table 2: Alarm Watch and Remote View Alarms*

| Priority | Tone Type* | Visual | Tone Duration |
|---|---|---|---|
| **High** | **Central**<br>Two bursts of five tones every 15 seconds, or continuous tone.<br>**Bedside**<br>One single tone. | Flashing key; message appears in red. | **Central**<br>Until the alarm condition is resolved or the tone is reset.<br>**Bedside**<br>One second. |
| **Medium** | **Central**<br>Burst of three tones every 30 seconds, or intermittent tone (one second ON, one second OFF).<br>**Bedside**<br>One single tone. | Flashing key; message appears in red. | **Central**<br>Until the alarm condition is resolved or the tone is reset.<br>**Bedside**<br>One second. |
| **Low** | **Central**<br>One tone every 30 seconds, or intermittent tone (one second ON, four seconds OFF).<br>**Bedside**<br>One single tone. | Flashing key; message appears in yellow. | **Central**<br>Until the alarm condition is resolved or the tone is reset.<br>**Bedside**<br>one second. |

* *The repetition rate for the High, Medium, and Low alarm tones can be adjusted by your system administrator.*

# Adjusting Alarm Tones and Key Tones

Alarm tones refer to the sound associated with an alarm condition. Key tones sound each time you touch a display key.

You can turn the alarm tone ON or OFF and adjust the tone volume for local alarms, for Remote View alarms, or for Alarm Watch alarms. While you are adjusting tone volume, a tone sounds briefly as an example of the new volume level.

**To set local alarm tones or key tones:**

- Touch MONITOR SETUP.
- Touch TONES.
- Select LOCAL ALARMS or KEY TONE.
- Select TONE / ON.
- Use the VOLUME↑ and VOLUME↓ keys to adjust.

**To set Remote View tones or Alarm Watch tones:**

- Touch MONITOR SETUP.
- Touch TONES.
- Select REMOTE ALARMS or ALARM WATCH.
- Select TONE / ON.
- Use the VOLUME↑ and VOLUME↓ keys to adjust.

***Warning:***

- ***Disabling alarm tones at a monitor eliminates alarm tones for all alarm conditions at that monitor, even in the case of life-threatening events.***
- ***Check alarm volumes periodically! Turning the volume off or too low may defeat the audible alarm function.***
- ***The two lowest volume settings of the 91387 produce less than 45 dBA at one meter from the internal speaker.***

Volume adjustments affect only the monitor where the adjustment is made. The volume of an alarm tone at a remote monitor must be adjusted at that monitor and cannot be adjusted remotely. A visual alarm notification is displayed until the condition is resolved, even if you disable the alarm tones at that monitor.

**Caution:**

**When Remote View is active at a bedside monitor, no Alarm Watch alarms will be displayed at that bedside monitor.**

The Remote View alarm tone only sounds when a remotely viewed parameter goes into alarm.

Alarm Watch tones sound when the Alarm Watch feature is active and an alarm condition exists on a watched monitor. The Alarm Watch feature must be enabled via the **Special Functions** menu for the Alarm Watch tone to sound.

# Silencing Alarm Tones and Alarm Suspend

The Alarm Suspend feature is only available at bedside monitors. If this feature has been disabled (set to OFF), the Alarm Suspend feature is not available.

## During an Alarm Condition

**If you touch TONE RESET once at a monitor during an alarm condition:**

- The alarm tone is silenced at the bedside monitor for 45 seconds. If the alarm condition continues, the alarm tone resumes at the monitor at the end of the 45-second period. If another parameter goes into alarm during this period, or if the initial condition ends and then begins again, the alarm tone will again sound at that monitor.

***Note:***

- *The single alarm tone may sound at other bedside monitors if a second or new alarm condition is recognized during the 45-second period.*
- ***TONE RESET** is applicable only to local bedside monitors; audio alarms continue at the central monitor.*

- The message *ALARM TONES SILENCED FOR 45 SECONDS* appears only on that monitor.
- All flashing parameter keys continue to flash.
- The TONE RESET key changes to ALARM SUSPEND.

**At a bedside monitor, when you touch ALARM SUSPEND within the 45-second period:**

- All alarms and alarm recordings are suspended for three minutes. No alarms sound for any reason during this period, and no new alarm recordings are produced.
- A message appears to indicate that all alarms are suspended.
- Trend data may not be collected. This feature can be enabled or disabled only by your system administrator.
- The ALARM SUSPEND key changes to RESUME ALARMS after the first key touch.

**To resume normal alarm operation at a bedside monitor within the three-minute period, touch RESUME ALARMS.**

**To suspend alarms at a bedside monitor when no alarm is sounding, touch the ALARM SUSPEND key once.**

## In the Absence of an Alarm Condition

Touching the ALARM SUSPEND key once when no parameters are in an alarm condition suspends the alarms at the bedside monitor for three minutes. (Refer to *During an Alarm Condition* on page 7-11.)

***Note:***

*You cannot suspend alarms from a central monitor. However, you can silence alarm tones for 45 seconds. Touching this key has no effect if it is touched at the central monitor when no alarm is sounding.*

# Controlling the Embedded Alarm Light (SL2400/SL2600 only)

The SL2400/SL2600 monitor's embedded alarm light helps you identify which monitor is in alarm. You can choose whether the alarm light flashes during alarms. For example, you may choose to not have the alarm light flash at night or while the patient has visitors.

**To enable or disable the embedded alarm light:**

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch ALARM LIGHT / ON to enable the alarm light.

  -OR-
- Touch ALARM LIGHT / OFF to disable the alarm light.

# Alarm Watch

With the network Alarm Watch feature, you can be notified at a local bedside or central monitor of all alarms from a remote bed. The Alarm Watch feature defaults to its last setting when the monitor is turned ON. The message *ALARM WATCH ON* appears on the bedside and on the central monitor when the Alarm Watch feature for a remote bed is active. The message *AW OFF* also appears on the central monitor for each bed not selected for Alarm Watch.

***Warning:***

- ***Remote View and Alarm Watch are mutually exclusive features on bedside monitors. When Remote View is active, NO Alarm Watch tones or messages display at the bedside monitor.***
- ***The MCM settings for individual parameter alarms at the remote bed control which alarms could appear in an Alarm Watch. Refer to the Module Configuration Manager System Administration Guide (P/N 070-1245-xx) for more information.***
- ***Using the Alarm Watch feature, you can watch for alarms from 32 other monitors. However, more than ten remote alarms cannot be reported simultaneously to any monitor using the Alarm Watch feature. The maximum number of monitors that may receive both a waveform and a message is 16.***

If your hospital protocol requires remote monitoring of all alarms, you can activate Alarm Watch during the setup of your bedside or central monitors. A central monitor can be configured with the Central Alarm Watch Manager to automatically watch every bed it is currently monitoring (refer to *Central Alarm Watch Manager* on page 7-14). Contact your system administrator regarding this feature.

When a parameter from a monitor that is under Alarm Watch goes into alarm, a message (for example, *ALARM WATCH – BED 28 ECG CHANNEL IN ALARM*) appears on the message line of the alarm-watching monitor. The appropriate tone sounds at the alarm-watching monitor (refer to *Table 2* on page 7-9). The corresponding parameter appears in the lowest zone on the display of the alarm-watching monitor (unless another alarm-watched parameter is in alarm and already occupies that zone at the watching monitor).

Refer to *Viewing Remote Parameters* on page 1-14 for more information.

**To enable Alarm Watch:**

- Touch SPECIAL FUNCTIONS.
- Touch ALARM WATCH.
- Select a bed.

  -OR-
- Select a subnet and then a bed.
- Ensure that the key for the desired bed(s) is selected.
- Touch ALARM WATCH / ENABLE.

**To disable Alarm Watch:**

- Touch SPECIAL FUNCTIONS.
- Select RV/AW OFF.

**To de-select beds for Alarm Watch:**

- Touch SPECIAL FUNCTIONS.
- Touch ALARM WATCH.
- Touch a bed key to de-select it.

  -OR-
- Touch DESELECT ALL.

### Caution:

- **Displayed alarm messages cycle from one to another every three seconds (up to a maximum of ten alarms) until all alarm conditions are resolved, or until you disable alarms at either the local monitor (through Remote View) or the remote monitor.**
- **Only one parameter on Alarm Watch can be viewed at a time. When subsequent, concurrent alarms occur for one patient or other patients on Alarm Watch, a message appears and a single, one-second advisory tone sounds.**

***Note:***

*Remember to enable Alarm Watch tones in the* ***Monitor Setup*** *menu to produce audible alarms (refer to Adjusting Alarm Tones and Key Tones on page 7-10).*

To resume Alarm Watch, touch ALARM WATCH / ENABLE. Alarm Watch is resumed for all previously selected patients. You can also add patients for Alarm Watch.

## Alarm Watch Rotation

The Alarm Watch feature on some monitors can be configured to rotate the visible active alarms through the Alarm Watch display zone. Active alarms being monitored will rotate in and out of the display zone based on settings made by your system administrator. The Alarm Watch rotation time, signal tone, and rotation algorithm are set in the **Alarm Watch Setup** menu in the clinical level of Privileged Access.

### ALARM WATCH SETUP

| ALARM WATCH SETUP |
|---|

| ROTATE ALARM WATCH | |
|---|---|
| ON | OFF |

| ALARM WATCH ROTATION | |
|---|---|
| PRIORITY | SIMPLE |

| ROTATION TIME | |
|---|---|
| 15 SEC | 30 SEC |

**ROTATE ALARM WATCH** — Turns the alarm rotation feature ON or OFF (if you select OFF, the ALARM WATCH ROTATION and the ROTATION TIME options are unavailable).

**ALARM WATCH ROTATION** — Selects either a rotation system allowing the higher priority alarms to rotate into the window more often (PRIORITY), or a simple rotation system allowing all alarms equal time in the rotation regardless of the alarm priority (SIMPLE).

**ROTATION TIME** — Selects the interval between rotations in the **Alarm Watch** dialog box.

## Central Alarm Watch Manager

The Central Alarm Watch Manager feature on your central monitor automatically selects all beds currently displayed on that central monitor for Alarm Watch. (This feature must be enabled by a system administrator.)

When the Central Alarm Watch Manager is activated, it displays alarms for each bedside that has the Alarm Watch feature enabled. The central monitor continues watching for alarm conditions from the selected bedside monitors until you either disable Alarm Watch for that bedside monitor or you disable the Auto Alarm Watch feature altogether.

## Alarm Tone Manager

A system administrator with a Biomed level of Privileged Access can enable the Alarm Tone Manager to prohibit an individual alarm tone from being permanently disabled.

A minimum volume can be set for alarm tones to ensure they are at a safe and audible level.

When the Alarm Tone Manager is disabled (this is the default setting), access to the TONES keys in the **Monitor Setup** menu is inhibited.

# Automatic Recording of an Alarm

Spacelabs Healthcare strongly recommends verifying alarm parameter settings on the monitor once during each shift and upon each patient admission.

An alarm recording prints the last 12 or 20 seconds (based on RECORDING DURATION setting), or until the alarm ceases or is suspended, whichever is greater. Recordings can be terminated at the printer by touching its STOP (or RESET) key, by taking the printer offline, or by turning the printer OFF. Printing on a network printer is configuration-dependent. Contact your system administrator for details.

The ALARM PARAMS key displays a menu of parameters that can initiate alarm recordings. If alarm recordings are disabled for a parameter, no alarm recording is produced on either the bedside or the network printer if that parameter goes into an alarm condition. However, the designated alarm tones are still generated and the alarm messages are displayed. Use the key labeled OTHER ON/OFF for any new parameter not yet on the **Alarm Parameters** menu.

When a printer is present in the monitor and is selected and online, an alarm recording is automatically directed to that printer. If a printer is not attached to the monitor, the recorder channel keys do not appear in the menu.

**To select parameters for alarm recording and generate automatic recordings on a bedside printer:**

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Select RECORDING DESTINATION.
- Select a destination for the alarm recording.
- Touch PREVIOUS MENU.
- Touch ALARM PARAMS.
- Select parameter key(s) ON to initiate a recording in case of alarm. If the parameter key is OFF, no alarm recording is produced for that parameter in an alarm condition.

# Alarm Limit Review

Touch the ALARM LIMIT REVIEW key on a bedside or central monitor to view alarm settings and the alarm volume for a selected monitor at that point in time. Touch the PRINT key at the bottom of the **Alarm Limit Review** dialog box to print the alarm settings.

**To view the Alarm Review dialog box:**

| Bedside Monitor | Central Monitor |
|---|---|
| • Touch SPECIAL FUNCTIONS.<br>• Touch ALARM LIMIT REVIEW. | • Touch SPECIAL FUNCTIONS.<br>• Touch ALARM LIMIT REVIEW.<br>• Select a bed.<br>-OR-<br>• Select a subnet and then a bed. |

• Use the scroll bar if necessary.

**To print the Alarm Limit Review, touch PRINT.**

The alarm settings for modules and Flexport interfaces that do not support this feature are displayed as NOT SUPPORTED.

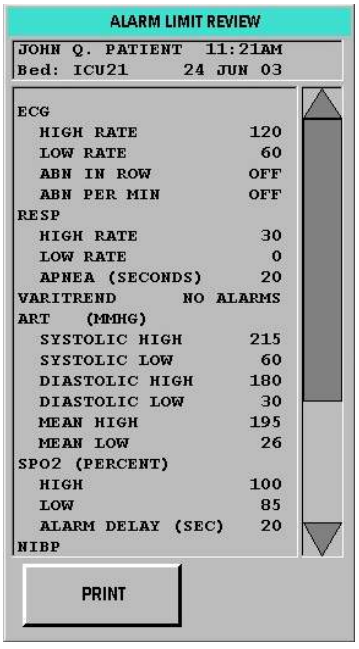



*Figure 7-1: Alarm Limit Review*

# Alarms Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Duplicate alarm recordings print at the bedside and system printer** | ■ Alarm recordings are directed to both bedside and network printers with the RECORDING DESTINATION key. | ■ Select THIS MONITOR or NETWORK for alarm recordings. |
| **No alarm recordings are printed** | ■ Parameters for alarm recordings are set to OFF. | ■ Select parameters for alarm recordings from the **Alarm Parameters** menu. |
| | ■ Bedside printer is OFF. | ■ Turn bedside printer ON. |
| | ■ The alarms have not been directed to the bedside printer. | ■ Ensure that THIS MONITOR or BOTH is selected. |
| | ■ Alarms are suspended for three minutes. | ■ Ensure that alarms are not suspended. |
| | ■ System printer is not identified as one of two network printers. | ■ Have your system administrator verify configuration. |
| | ■ Printer is out of paper. | ■ Load paper into printer. |
| **Alarms continue to violate after touching ALARM SUSPEND** | ■ More than one alarm may be in violation. | ■ Touch ALARM SUSPEND again. |
| **No alarm notification occurs at a central monitor** | ■ The Alarm Watch feature is not active. | ■ Activate Alarm Watch for the desired beds at the central monitor. |
| | ■ Parameters not displayed. | ■ Display the desired parameters using SCREEN FORMAT under MONITOR SETUP. |
| **Cannot interact with ALARM WATCH parameter** | ■ The monitor may not be configured to allow interaction with remote parameters. | ■ Contact your system administrator. |

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Cannot deselect ALARM WATCH** | ■ The central monitor is configured with Central Alarm Watch Manager to prevent de-selection of automatically alarm-watched beds. | ■ Contact your system administrator. |
| **SL2400/SL2600 monitor's alarm light does not work** | ■ The monitor may not be configured to allow the alarm light to work. | ■ Contact your system administrator. |
| | ■ The alarm light may be set to OFF. | ■ Touch MONITOR SETUP, MONITOR CONFIG., then ALARM LIGHT / ON. |

# Admit/Discharge

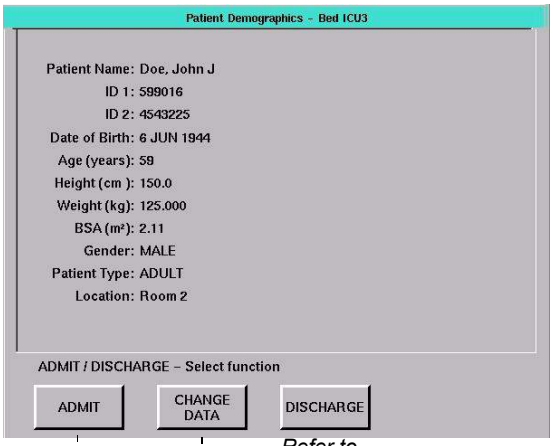
## Directory of Keys

### Admitting a Patient

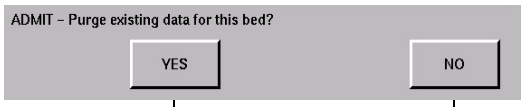



*Refer to Introduction* | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

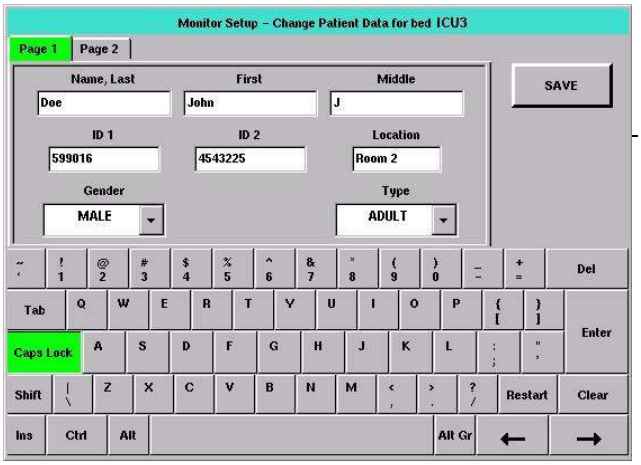
*Refer to page 8-2*



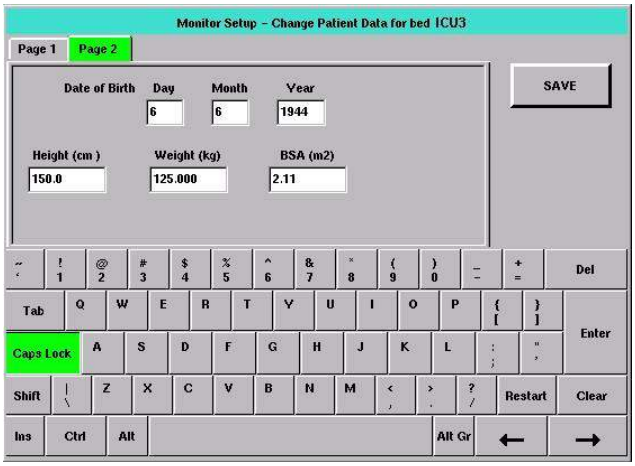

*Refer to page 8-2*



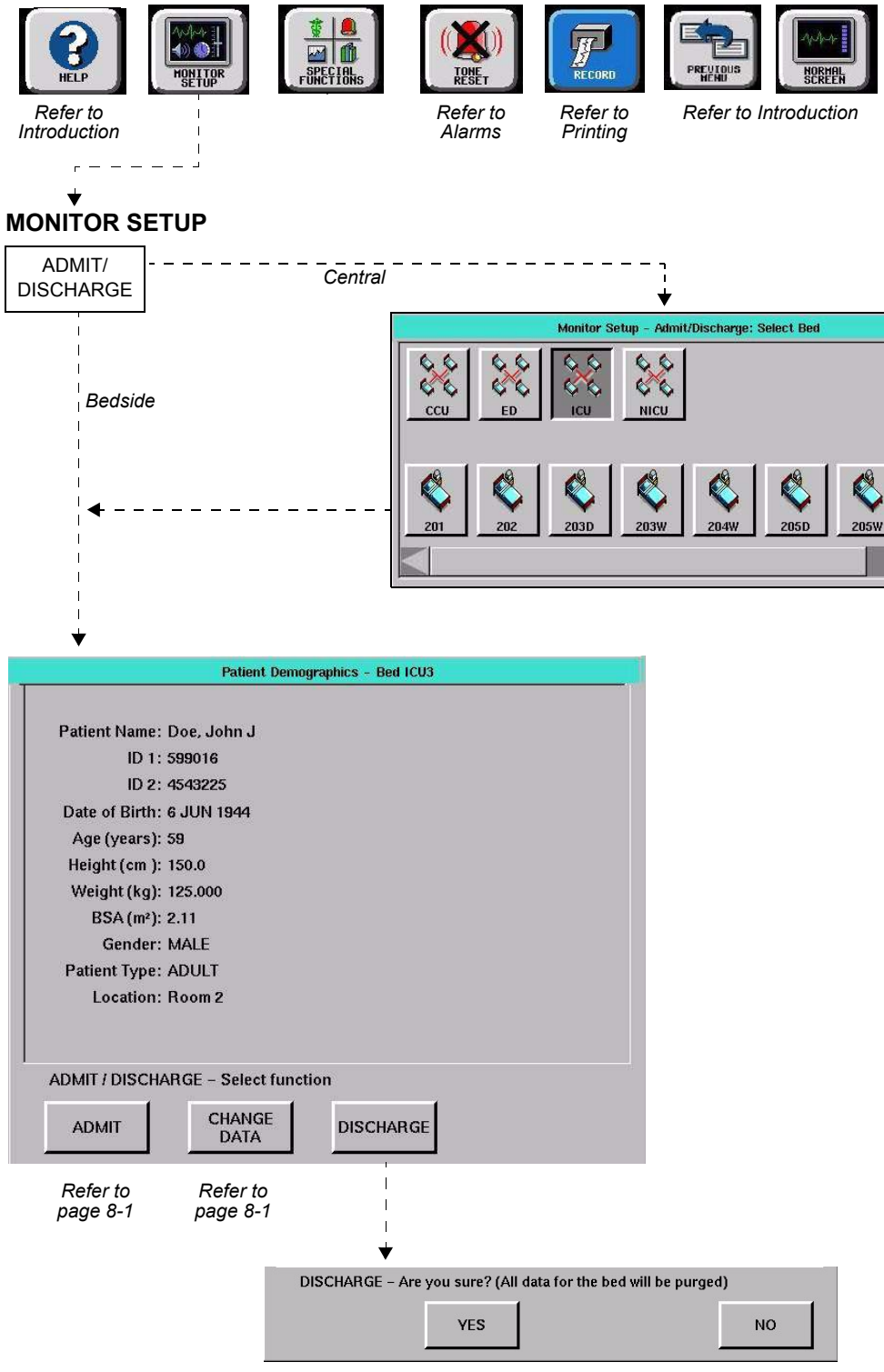

Page 1




Page 2



# Discharging a Patient



# Admit/Discharge

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## Overview

This chapter describes how to enter new patient data, change data for an existing patient, and delete patient data if the patient is discharged. You can access the **Admit/Discharge** menu either from the central monitor or from a bedside monitor. However, if you are accessing this menu at a central monitor, you must also select the patient's bed (this is not necessary at a bedside monitor).

The only information required when admitting a patient to the system is the patient's name (up to 40 characters per field). Entering the patient's ID number (up to 15 characters) or other demographic data is optional.

## Changing or Entering New Patient Data

Touch the ADMIT/DISCHARGE key on the **Monitor Setup** menu to display the **Patient Demographics** dialog box (refer to *Figure 8-1*).

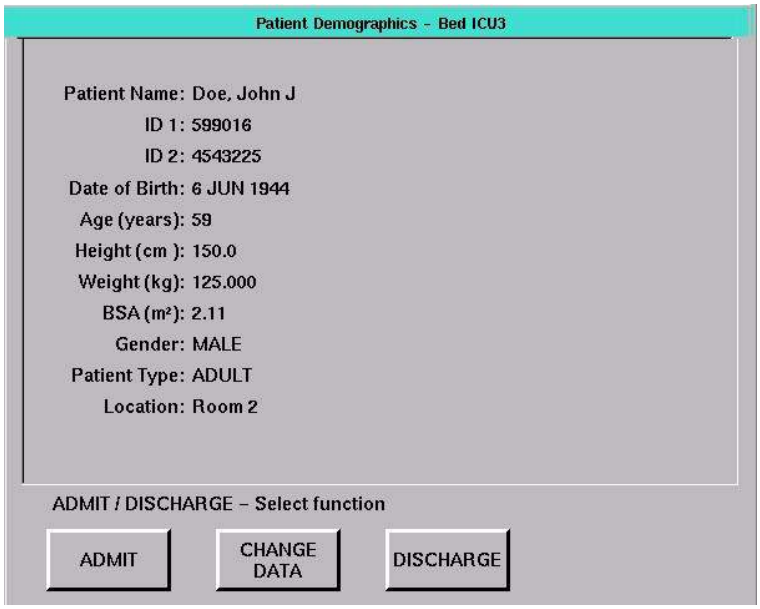



*Figure 8-1: Patient Demographics dialog box*

**To access the Patient Demographics dialog box:**

| Bedside Monitor | Central Monitor |
|---|---|
| • Touch MONITOR SETUP.<br>• Touch ADMIT/DISCHARGE. | • Select a bed.<br>-OR-<br>• Select a subnet and then a bed. |

**To admit a new patient:**

- Touch ADMIT.
- Select YES to purge the existing data for that bed.
- Select a field and enter information using the on-screen keyboard (or the drop-down lists for **Gender** and **Patient**). (Touch ENTER to move to the next field.)
- Touch the **Page 2** tab to access additional patient data fields.
- Touch SAVE to store the new patient data.

**To change existing patient data:**

- Touch CHANGE DATA.
- Follow the last three steps under “To admit a new patient” above.

**To discharge a patient:**

- Touch DISCHARGE.
- Touch YES to purge the existing data.

To admit a new patient, touch the ADMIT key on the **Patient Demographics** dialog box. YES and NO keys appear at the bottom, along with a prompt to purge the existing data (refer to *Figure 8-2*).

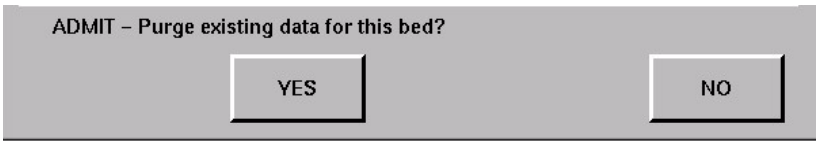



*Figure 8-2: Purge existing data*

Touch YES to open the **Admit Patient Data** dialog box. The fields are blank for you to enter new patient information.

To change existing patient information, touch the CHANGE DATA key on the **Patient Demographics** dialog box. This key is disabled if there is no patient name or no ID number stored in the system. The information displayed in the **Change Patient Data** dialog box matches the information that was displayed in the **Patient Demographics** dialog box.

### Caution:

- **Only use CHANGE DATA to update information on an existing patient.**
- **Never use CHANGE DATA to enter information for a new patient. Discharge the existing patient, which purges the data from the monitor, before entering data for a new patient.**

You can use the on-screen keyboard to enter or change patient information. You can also use an external computer keyboard to enter patient data into the selected field. Touching the **Page 2** tab accesses additional patient data fields (refer to *Figure 8-4*).

Selecting the **Gender** field lists three choices — blank, MALE, and FEMALE.

The **Type** field displays ADULT by default. Change this field to NEONATE, if appropriate. On central monitors, the **Type** field is unavailable if the remote monitor where the admission occurs does not support the Type selection.

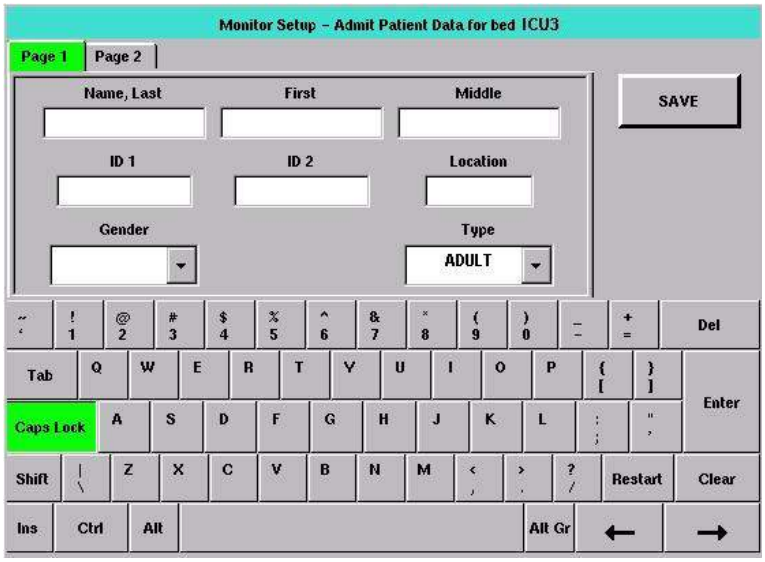



*Figure 8-3: Entering patient information — Page 1*

- **Del** — Deletes the character to the left of the cursor.
- ← Moves the cursor left one position.
- → Moves the cursor right one position.
- **Restart** — Re-displays the last name or value stored and deletes all earlier changes.
- **Clear** — Deletes the currently displayed name or value.
- **Enter** — Moves to the next field.
- **Caps Lock** — Locks the keyboard in ALL CAPS mode.
- **Shift** — Toggles the SHIFT mode ON and OFF.
- **Ins** — Toggles the INSERT mode ON and OFF.
- **Spacebar** — Inserts a space.

- **SAVE** — Enters the data into the system and completes the Admit procedure.
- **Tab** — Moves to the next input field.
- **Ctrl** — Causes the next key to be treated as a control character.
- **Alt** — Causes the next key to be treated as an alternate control character.
- **Alt Gr** — Causes the next key to be treated as an alternate graphics character.

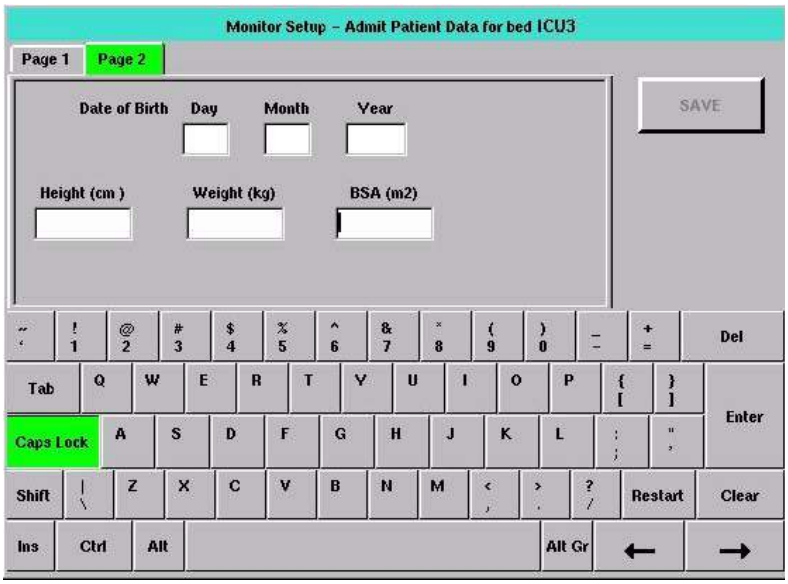



*Figure 8-4: Entering patient information — Page 2*

## Entering Height, Weight, and Body Surface Area (BSA)

You can adjust the values for height, weight, and BSA up or down within the valid range (refer to *Table 1*). The values last set for height, weight, and BSA remain until they are manually changed.

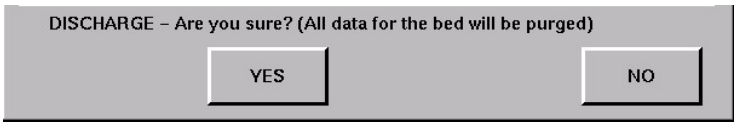
Height and weight can be displayed in either U.S. or metric units (contact your system administrator for details). The system automatically computes BSA from the values entered for height and weight, and uses this BSA value to obtain indexed values for physiologic calculations, such as cardiac output.

*Table 1: Height, Weight, and BSA Ranges*

| Field | Units | Valid Range |
|---|---|---|
| Height | cm<br>in | 20 to 215<br>7.9 to 84.6 |
| Weight | kg<br>lb | 0.2 to 250<br>0.44 to 551.16 |
| BSA | $m^2$ | 0.03 to 3.69 |
| BSA = $Ht^{0.725} \times Wt^{0.425} \times 0.007184$ | | |

# Discharging a Patient

To clear the bedside monitor of existing patient data, touch the DISCHARGE key. Touch YES to purge the existing patient data to complete the discharge.




# Scanning Barcoded Demographic Data

***Note:***

*Only bedside monitors support scanning of barcoded demographic data.*

Scanning a valid demographic data barcode reduces the patient admission process time by automatically replacing the currently displayed demographic data with the scanned data.

The **Barcode Verification** dialog box includes a **Scanned** column containing the newly scanned data, and a **Current** column containing the data currently stored in that monitor. The information in the **Scanned** column updates as additional data is scanned.

**The scanning process differs as follows, depending on the data being scanned:**

- If the scanned data includes the same **Patient Name** and **ID 1** number as the current data, follow the instructions under *Scanned Data with Same Name and ID 1 Number* below.
- If the scanned data includes a different **Patient Name** or **ID 1** number than the current data, follow the instructions under *Scanned Data with Different Name and ID 1 Number* on page 8-9.

## Scanned Data with Same Name and ID 1 Number

1 Scanning a barcode displays the following **Barcode Verification** dialog box. The SAVE and CANCEL keys allow you to store the barcode input or cancel it (refer to *Figure 8-5*).

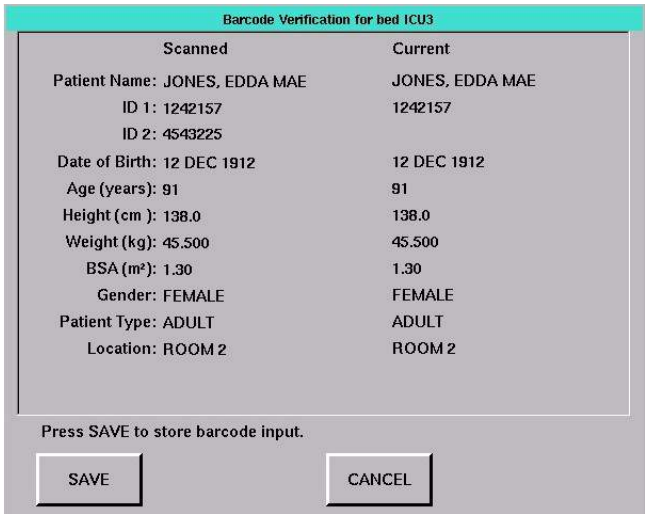



*Figure 8-5: Barcode Verification dialog box with SAVE/CANCEL keys*

2 Touching SAVE or CANCEL displays the **Patient Demographics** dialog box with keys labeled ADMIT, CHANGE DATA, and DISCHARGE along the bottom.

- If you touch CANCEL, the information from the **Current** column appears (refer to *Figure 8-6*).
- If you touch SAVE, the information from the **Scanned** column appears (refer to *Figure 8-7*).

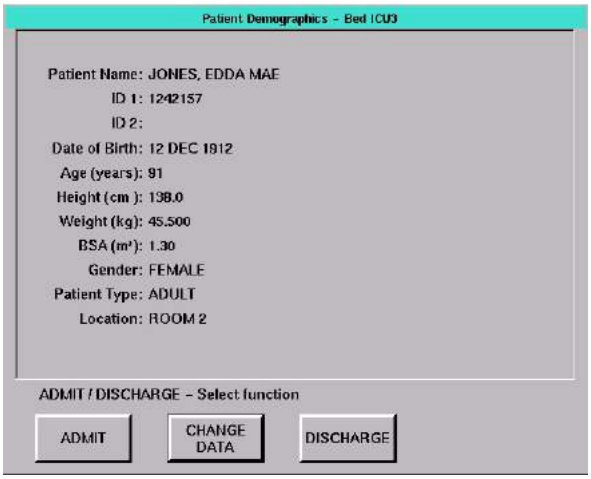



*Figure 8-6: Scan cancelled*

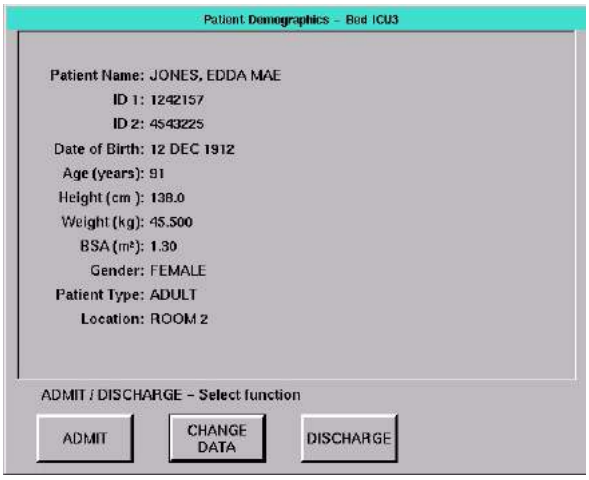



*Figure 8-7: Scan saved*

3 Complete the admission as described in *Changing or Entering New Patient Data on page 8-3*.

## Scanned Data with Different Name and ID 1 Number

1 Scanning a barcode displays the following **Barcode Verification** dialog box.You are then requested to verify the purge of existing (current) data (refer to *Figure 8-8*).

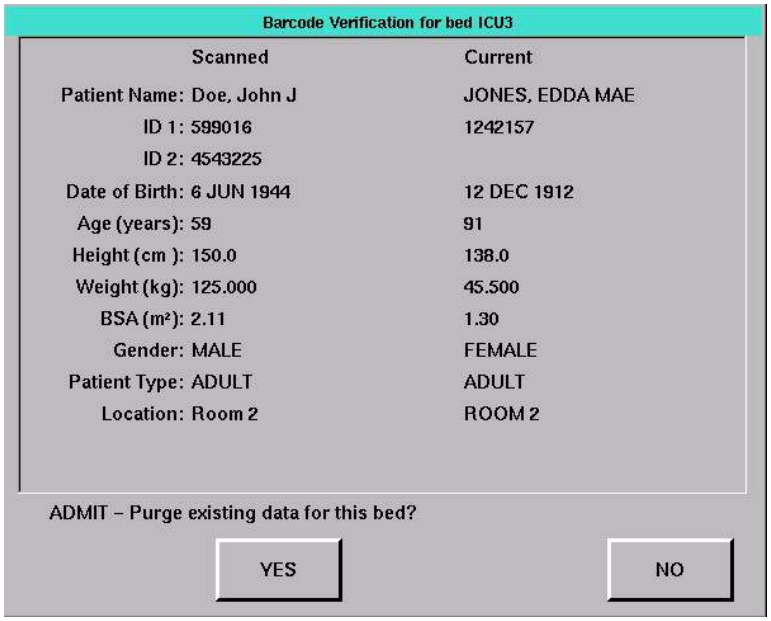



*Figure 8-8: Barcode Verification with purge confirmation keys*

2 Touching YES or NO displays SAVE and CANCEL keys at the bottom of the dialog box.

- If you touch NO, then the existing data is not purged and the **Current** column remains the same (refer to *Figure 8-9*).
- If you touch YES, then the existing data is purged and all information in the **Current** column (except Patient Type) is cleared (refer to *Figure 8-10*).

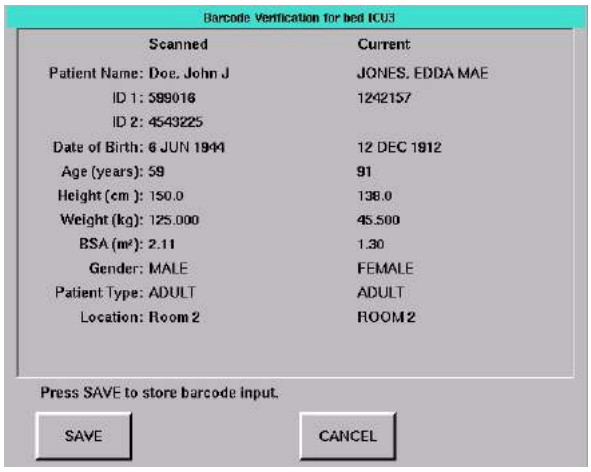



*Figure 8-9: Data not purged*

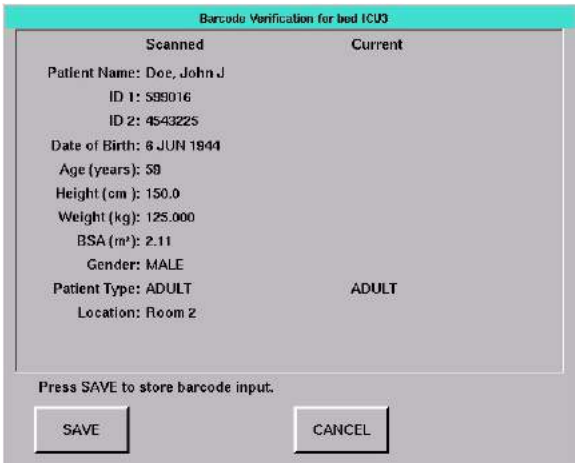



*Figure 8-10: Data purged*

3 Touching SAVE or CANCEL displays the **Patient Demographics** dialog box (refer to *Figure 8-11* and *Figure 8-12*).

- If you touch CANCEL, then the information matches the **Current** column in *Figure 8-9*.
- If you touch SAVE, then the information in the **Scanned** column in *Figure 8-10* is stored and displayed.

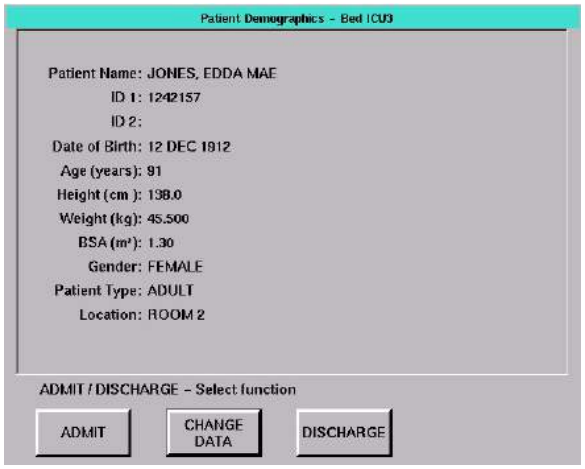



*Figure 8-11: CANCEL selected*

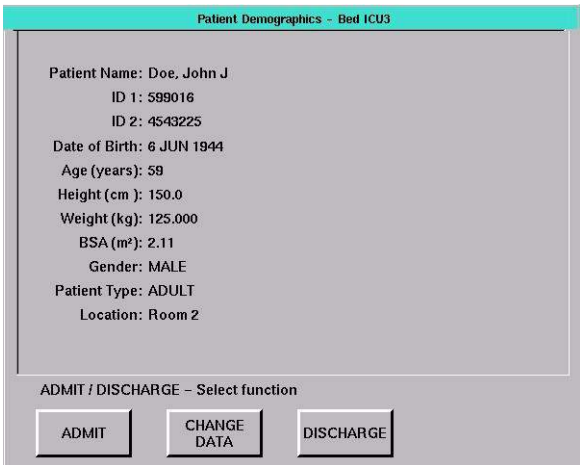



*Figure 8-12: SAVE selected*

4 Complete the admission as described in *Changing or Entering New Patient Data on page 8-3*.

# Admit/Discharge Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Patient name incorrect as entered on keyboard menu** | ■ Name exceeds 40 character maximum and system has written over some characters. | ■ Re-enter name using 40 characters or fewer. |
| | ■ No patient name or ID number stored in system. | ■ Enter name or ID number. |

# Printing

## Directory of Keys

### Setting up the Printer




*Refer to Introduction*

*Refer to Alarms*

*Refer to Introduction*

**MONITOR SETUP**

RECORDER CONFIG.

**RECORDER CONFIGURATION**

RECORDING DURATION | ALARM PARAMS | RECORDING DESTINATION

**Number of Recorder Channels**

1 | 2 | 4 | VITALS SETUP

**4 channels supported by 90469 only*

*SL2400/ SL2600 monitor only*

**Configure parameters or start vitals recording**

DATA INTERVAL | START TIME | SELECT PARAMETERS | PRINT VITAL SIGNS

**Alarm Recordings to:**

THIS MONITOR | NETWORK | BOTH

**Other Recordings to:**

THIS MONITOR | NETWORK

**Select parameters which require alarm recording from bed x**

| ECG | | RESP | | ... | MORE |
|---|---|---|---|---|---|
| ON | OFF | ON | OFF | | |

**Select duration of recordings initiated from this monitor**

12 SEC | 20 SEC

## Obtaining Recordings from the Monitor




*Refer to Introduction*

*Refer to Alarms*

*Refer to Introduction*

*Touch RECORD once*

*Touch RECORD twice*

**RECORDER MENU**

| CONTINUOUS RECORD | RECORD ALL | RECORD PRESELECTED A | RECORD PRESELECTED B | PRINT VITAL SIGNS |
|---|---|---|---|---|

*Touch this key, then touch the desired parameter key (up to four), for each parameter to be continuously recorded*

*SL2400/SL2600 monitor only*

## Controlling Recordings from the Monitor

**SYSTEM PRINTER MODULE**

| PRINTER (1 - 8) |
|---|

**SL2400/SL2600 Printer**

| PRINTER CONTROLS |
|---|

**PRINTER CONTROL MENU**

| STOP RECORDING | CONVERT TO CONTINUOUS | SLOW | | PRINTER | |
|---|---|---|---|---|---|
| | | ON | OFF | ON | OFF |

# Defining Preselected Recordings




*Refer to Introduction*

*Refer to Alarms*

*Refer to Introduction*

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter Clinical password*

PRESELECTED RECORDINGS

**PRESELECTED RECORDINGS - Select configuration to change**

PRESELECTED A | PRESELECTED B

**Select option to change - X: (current selection displays)**

SELECT TYPE | SELECT BED

**Select beds/subnets - X: (current selection displays)**

ALL SUBNETS | THIS SUBNET | THIS MONITOR | ALL BEDS ON THIS MONITOR

**Select recording type - X: Beds = (current selection displays)**

ALL BEDSIDE PARAM(S) | ↑ | ↓ | CONFIGURED PARAMETERS

# Printing

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## Overview

**This chapter describes the following Spacelabs Healthcare printers:**

- 90449 bedside printer module
- 90469 (two- and four-channel) system printer module
- SL2400/SL2600 printer (optional)
- 90838 PrintMaster laser printer

**Printers can provide printouts of the following:**

- Automatic recordings of any parameter in an alarm condition (if configured in the Module Configuration Manager and if the Alarm Parameters function is enabled for that parameter).
- Parameter data such as:
  - patient name, bed name, and time and date of the printout
  - vital signs, edge annotation, and scaling information
  - waveform data (including timing tick marks and a grid)
  - arrhythmia/ST segments

- Non-waveform data displayed on-screen, such as:
  - tabular trends
  - hemodynamic calculations
  - drug dose calculations
  - graphic trends
  - alarm limits review
  - Vitals report (SL2400/SL2600 monitor only)

# Printing Configurations

Each Spacelabs Healthcare, network-connected, patient monitor is capable of sending recordings to either of two network printers. These can be configured in several ways.

**Configuration #1**

**The two printers share the printing load, and the monitor automatically determines which printer is best for each type of recording:**

- Generate the most timely output of high priority recordings.
- Ensure that subsequent recordings from one patient over a short time span are processed by one printer.
- Use paper as efficiently as possible.

When the printing load is heavy, these objectives may conflict.

**The following factors are taken into consideration when a print request occurs:**

- Are either of the two printers outputting, holding in memory queue, or loading in queue a print job from this monitor?
- Are either of the printers idle?
- Is this a high priority request (alarm vs. manual)?
- Are either of the printers currently printing a continuous recording?
- Are either of the printer's queues full?
- Which of the printers is the preferred size for this request (1, 2, or 4 channels)?

At the time of a printing request, the monitor from which the request originated evaluates both of the available printers one at a time, providing a score for each of the two printers. Each printer's evaluation passes all the way through the priority tree from the score at the top of the tree to the score at the bottom of the tree. The printer generating the highest score gets the job. If the evaluation produces the same score for each printer, the print job is sent to the printer designated as the primary printer for that monitor.

**Configuration #2**

One printer is designated as the primary and the other printer is designated as the backup.

**All recordings are sent to the primary printer, unless it is unable to print for one or more of the following reasons:**

- Off-line
- Out of paper
- Disconnected from network
- Powered OFF
- Print queues are full
- Unable to accept recording type

If the primary printer is unable to print, the recordings are then sent to the backup printer, unless it is also unable to print for a reason listed above.

**Configuration #3**

Only one printer is available because the network is configured so that recordings from a given monitor are directed to only one printer on the network. During times of simultaneous multiple bed alarms, the selection rules will not be applicable, and print performance will be affected.

# Printing Priorities

**The following list defines printing priorities from the highest to lowest:**

- Alarm recording or a manual recording request via a monitor
- RECORD ALL request via a bedside monitor
- RECORD ALL request via a central monitor
- Non-waveform recordings (for example, trends)
- All Arrhythmia/ST classes

**In all network printing cases:**

- High priority print jobs bump lower priority jobs. For instance, an alarm recording will bump graphic trends to a lower position in the print queue.
- A high priority request erases as many lower priority requests as needed to make room for the data it contains. For example, a fully loaded printer will bump graphic trends out of the queue.

A status message is not displayed when a print request replacement occurs.

***Note:***

*Recordings in the process of being printed cannot be interrupted or delayed by additional print requests.*

## Recording Buffer and Printer Transitions

The printer modules have limited ability to store the waveform data for additional printouts while actively printing.

A continuous manual printout or an alarm printout may exceed the capacity of the printer module's storage buffer. When the current printout ends and the next queued printout begins, the printer will output the stored waveform data, followed by current waveform data. A printer transition indicator displays between the end of the stored waveform data and the beginning of the current waveform to mark a section of missing waveform data. The width of the indicator is constant. It does not indicate the amount of missing data, just that there is data missing.

The printer transition indicator is indicated on the printer strip by a downward line, followed by a bottom flatline, then a rapid return to the waveform (refer to *Figure 9-1*).

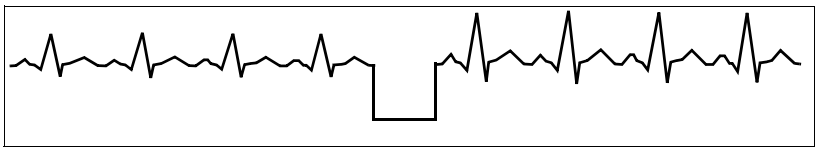


*Figure 9-1: Print transition indicator*

# 90449 Printer Module

The 90449 printer module (refer to *Figure 9-2*) is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm, fanfold paper. This printer module prints recordings of parameters in alarm conditions, in requested waveforms, and in non-waveform data.

***Note:***

*This 90449 is not designed for use as a system printer and will not function correctly if used in this manner.*




*Figure 9-2: 90449 bedside printer module*

## Loading Paper

When loading paper into the paper tray, the small, black, rectangular cue mark on the bedside printer paper must face out and be at the bottom of the tray. Each recording begins at the Z-fold perforation, and blank sheets are not placed between successive print requests.

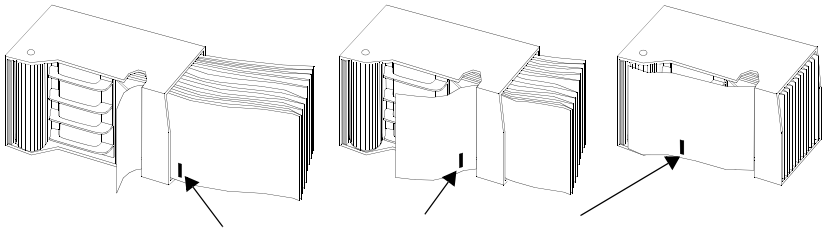


*Figure 9-3: Bedside printer module paper tray*

***Note:***

*Note the orientation of the small cue mark.*

**To load paper:**

- Press the **Eject** button next to the PAPER OUT light.
- Pull out the plastic paper tray.
- Discard old cardboard retainer inside tray.
- Remove the label from the new paper, but keep the cardboard retainer in place around one end.
- Start inserting the paper into the paper tray, beginning with the cardboard retainer end.
- With the paper halfway into the paper tray, lift up the spring-loaded roller.
- Bring out the top fold of paper from under the top end of the cardboard retainer.
- Bring the top fold over the top of the spring-loaded roller.
- Release the spring-loaded roller onto the remainder of the paper.
- Insert the stack fully.
- Unfold the paper and position it over the top of the black roller at the end of the tray.
- Slide the tray completely back into the printer module.

# 90469 System Printer Module

The 90469 system printer module (refer to *Figure 9-4*) is a two- or four-channel printer that provides automatic and manual recordings of parameter data on 50-mm or 120-mm, Z-fold paper. The system printer module prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data. The system printer module can be used with either a bedside or the central monitor.



*Figure 9-4: 90469 system printer module*

## Loading Paper

The system printer module has a slide-out, plastic tray that accepts packets of Z-fold paper. The two-channel printer uses 50-mm wide by 27-m long paper. The four-channel printer uses 120-mm wide by 45.7-m long paper. Each single sheet has a small, black, rectangular cue mark located along the edge that is used to load the paper into the tray (refer to *Figure 9-5*).

**To load paper:**

- Press the **Eject** button next to the PAPER OUT light.
- Pull out the plastic paper tray.
- Discard the old cardboard retainer inside the tray.
- Remove the label from the new paper, but keep the cardboard retainer in place around one end.
- Start inserting paper into the tray, beginning with the cardboard retainer end.
  Make sure that the black cue marks are on the top edge of the pages for the four-channel printer and on the bottom edge of the pages for the two-channel printer.
- Insert the stack fully.
- Unfold the paper and position it over top of the black roller at the end of the tray.
- Slide the tray completely back into the printer module.



*Figure 9-5: System printer module paper tray*

# SL2400/SL2600 Printer (optional)

The printer in the SL2400/SL2600 monitors is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm roll paper. The printer prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data.

## Loading Paper

The printer uses 50-mm wide by 30-m long rolls of thermal paper and has an automatic self-feed mechanism for threading the paper through the rollers (refer to *Figure 9-6*).

**To load paper:**

- Press the release button on the door.
- Open the paper tray door all the way.
- Snap the new roll into place with the paper feeding from the bottom as shown in *Figure 9-6*.
- Pull out 6 to 12 inches of paper.
- Close the door.

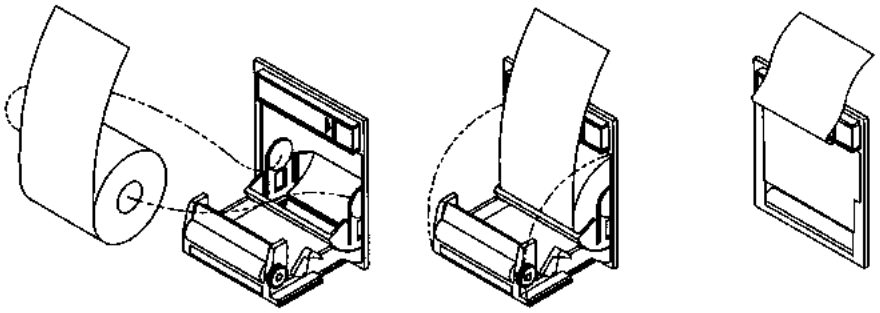


*Figure 9-6: Loading printer paper*

# PrintMaster

The 90838 PrintMaster (refer to *Figure 9-7*) is a four-channel, network printer that provides automatic recordings and manual recordings of parameter data on 8.5-inch × 11-inch or A4-size paper. The PrintMaster functions the same as the bedside printer module and the system printer module, in that it prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data. The PrintMaster consists of a central processing unit and a compatible laser or LED printer.

***Note:***

*Most of this section applies specifically to the laser printer provided by Spacelabs Healthcare for PrintMaster. For other printers, refer to that printer's operations manual for equivalent information.*

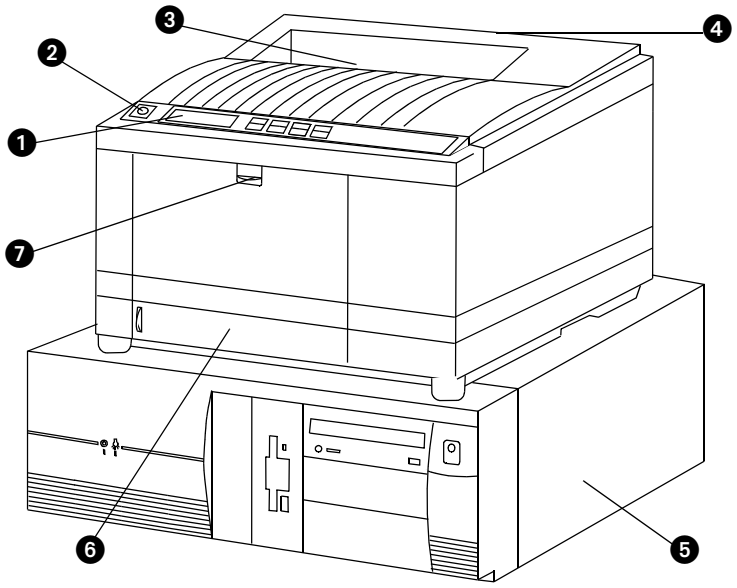



*Figure 9-7: Typical PrintMaster configuration*

1. Display panel
2. Top cover release
3. Top printout tray
4. Rear cover release
5. Central processing unit
6. Paper drawer
7. Front cover release

**The PrintMaster beeps every 15 seconds under the following conditions:**

- Paper jam
- Missing toner cartridge
- Top cover or back door open
- Power to printer is OFF
- Power cord is disconnected
- Printer cable is disconnected
- Printer in NOT READY mode

## Loading Paper

The printer provided by Spacelabs Healthcare for PrintMaster has a slide-out paper drawer that accepts up to 500 pages of 8.5-inch × 11-inch or A4-size copy paper.

**To load the paper into the paper drawer:**

1 Slide the drawer out of the printer.

2 Place the paper in the proper orientation into the paper drawer.

3 Place the paper drawer back into the printer.

For other laser printers, refer to that printer's operations manual for information on paper capacity and how to load the paper.

## Clearing Paper Jams

If a paper jam occurs in the PrintMaster, a message appears, indicating the location of the jam.

**In general, to begin printing again:**

1 Clear the jam in the area indicated by the paper jam message.

2 Close the cover.

3 Allow the printer to warm up.

The printer will then print all the pages affected by the jam.

**One of three paper jam messages may appear on the printer screen:**

*Table 1: PrintMaster Paper Jam Messages*

| Message | Action |
|---|---|
| *PAPER INPUT JAM* | 1 Pull out the paper drawer.<br>2 Remove the sheet that did not feed.<br>3 Inspect the remaining sheets to ensure that they are not wrinkled or stuck together.<br>4 Close the paper drawer.<br>5 Open and close the top cover to clear the paper jam message. |
| *PAPER FEED JAM* | 1 Open the top cover.<br>**Caution:**<br>**The fusing is hot.**<br>2 Lift out the image drum cartridge.<br>3 Carefully remove the jammed paper.<br>4 Replace the image drum cartridge.<br>5 Close the top cover. |
| *PAPER EXIT JAM* | 1 Open the top cover and the rear cover to release the roller pressure.<br>**Caution:**<br>**The fusing is hot.**<br>2 Pull the paper out from the rear or inside of the printer.<br>3 Close the top and rear covers. |

## Terminating a Print Job

To cancel any print job in process, such as a multi-page print job that is currently printing, power the printer OFF (until the front panel lights go out) and then turn it back ON.

## Replacing the Toner Cartridge

**When the *TONER LOW* message appears on the PrintMaster printer screen:**

1 Open the top cover.

2 Lift and pull the toner cartridge out at an angle.

3 Insert the new cartridge.

4 Close the top cover.

## Printer Screen Messages

Refer to your printer's operations manual to determine messages displayed on the printer's LCD display.

# Printer Key Functions

Printer control keys for the printer modules may be located on the front of the module. The printer can also be controlled by keys on the monitor itself.

**To access printer control keys from the monitor:**

- Touch NORMAL SCREEN.
- Press the printer controls or press the printer number key.
- Select the desired key.

*Table 2: Key Descriptions*

| Key | Function |
|---|---|
| SLOW ON/OFF | Changes the print speed of waveform recordings to 6.25 mm/second. Pressing SLOW a second time returns the printer to the current system sweep speed. SLOW has no effect on the print speed of non-waveform recordings (such as data tables and graphics). |
| CONTINUE | • When the printer is offline, press this key to feed roll paper at 25 mm/second or to feed one sheet of perforated paper through the printer module.<br>• When the printer is online and is currently printing a 12- or 20-second waveform recording, press CONTINUE to convert to a continuous recording. If you press CONTINUE, then the 12- or 20-second recording completes, followed by a horizontal line, and then the current data. The horizontal line appears, even on recordings that are not in a queue, but are the only request. |
| STOP RECORDING | • Stops any printing currently in progress and moves to the next print request in the queue.<br>• Stops any roll paper advance currently in progress. |
| PRINTER ON/OFF | Takes the printer offline without turning the power OFF. Alarms and print requests will be ignored. A LED (located either in the key or on the front panel of system printer) illuminates when this function is selected. |

# Selecting Print Duration

## Waveform Data

In the absence of an alarm condition, the origin of a print request determines the length of time waveform data (ECG, ART, RESP, etc.) are recorded. Recordings begin with a few seconds of data received just prior to the print request, followed by real-time data.

Recordings requested via the monitor are either 12 or 20 seconds in duration. This recording duration is selected by pressing the RECORDING DURATION key. (The RECORDING DURATION key will not appear if the recording duration has been preset and locked by your system administrator.)

**To select print duration from the monitor:**

- 
- Touch RECORDER CONFIG.
- Touch RECORDING DURATION to change the length of time for printing.

## Non-Waveform Data

The length of time required for the printer to print non-waveform data, such as graphs and data tables, depends on the complexity of the data and cannot be pre-determined.

# Selecting Recording Destination

**The Recording Destination menu enables you to direct:**

- Alarm recordings to a bedside printer, a network printer, or both.
- Other recordings to a bedside printer or a network printer, but not both.

***Note:***

*Twelve-lead ECG reports always print at the 90838 PrintMaster or ICS printers, if available, regardless of the recording destination settings.*

**To generate automatic recordings on a bedside printer and to select parameters for alarm recording:**

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Select RECORDING DESTINATION.
- Select a destination for the alarm recording.
- Touch PREVIOUS MENU.
- Touch ALARM PARAMS.
- Select parameter key(s) ON to initiate a recording in case of alarm. If the parameter key is OFF, no alarm recording is produced for that parameter in an alarm condition.

# Recording Alarms

***Note:***

*Recordings in the process of printing cannot be interrupted or delayed by a new alarm condition.*

An alarm recording may be triggered whenever a parameter enters an alarm condition. These alarm recordings can be set to OFF so that a printer will not respond to an alarm condition (the alarm tone and accompanying alarm message are unaffected). Refer to *Automatic Recording of an Alarm* on page 7-15 for more details.

Alarm recordings begin with several seconds of pre-alarm waveform data and continue for as long as the alarm condition exists (for a minimum of 12 seconds).

# Printing via Monitors

## Waveform Data

Waveform data is printed using the RECORD key on the monitor.

Each time you touch RECORD on the monitor, the CONTINUOUS RECORD key appears and waveform parameter keys flash for up to two seconds. You must make your key selection within this two-second time period. Making a selection causes the parameter keys to flash for an additional two seconds. Once the parameter keys stop flashing, any waveforms that have been selected are automatically sent to the printer for recording.

***Note:***

- *Requests for printing waveform data are limited to those waveform parameters currently displayed. The ECG split-view or full-view displays only include the first four displayed waveforms.*
- *If a parameter menu is left on the display, the CONTINUOUS RECORD key is not displayed.*

Touch the RECORD key twice to display the **Recording** menu.

**From the Recording menu you can:**

- Print all parameters currently displayed by touching RECORD ALL.
- Initiate a preselected group of recordings by touching RECORD PRESELECTED A or RECORD PRESELECTED B.
- Select PRINT VITAL SIGNS to manually print the vital signs you have selected. Refer to *Vitals Report (SL2400/SL2600 monitors only)* on page 9-22 for additional information.

**To start a manual recording via the monitor:**

- Touch RECORD.
- Touch up to four flashing parameter keys.
- Touch CANCEL RECORD SELECTION(S) to terminate.

  -OR-
- Touch STOP RECORDING in the Printer Control menu to terminate.

**To start a continuous recording via the monitor:**

- Touch RECORD.
- Touch CONTINUOUS RECORD, then touch the desired parameter key (up to four, for each parameter to be continuously recorded).
- Touch CANCEL RECORD SELECTION to restart the selection process.

**To stop a continuous recording via the monitor:**

- Touch RECORD.
- Touch STOP CONT. RECORD.

  -OR-
- Touch STOP RECORDING in PRINTER CONTROLS.

## Group Recordings

RECORD ALL and PRESELECTED A or B recordings are eight seconds in duration. The printer does not combine the parameters of different patients onto the same printout. Instead, it prints all the requested parameters for one patient before printing the parameters for the next patient.

**To print group recordings via the monitor:**

- Touch RECORD twice.
- Touch RECORD ALL.

  -OR-
- Touch RECORD PRESELECTED A or B.

## Non-Waveform Data

The RECORD key is not used for printing non-waveform data on a central or bedside monitor. As a result, non-waveform information must be displayed before it can be printed. When you display non-waveform data on a central or a bedside monitor, a PRINT key appears. If the information cannot fit on the paper at one time, it is separated horizontally, printing first the top half and then the bottom half of the display.

A single non-waveform recording may take up as much room on the paper as two simultaneous waveform recordings.

# Defining Preselected Recording Keys

The Preselected Recordings function (accessed through the Clinical level of Privileged Access) enables you to define which beds and parameters will be automatically recorded.

**To define the PRESELECTED A and B parameters:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch PRESELECTED RECORDINGS.
- Touch the key to be defined (PRESELECTED A or PRESELECTED B).
- Touch SELECT TYPE.
- Touch ALL/FIRST *n* BEDSIDE PARAM(S) and use the arrow keys to cycle through parameter selections: ALL BEDSIDE PARAM(S) or FIRST *n* BEDSIDE PARAM(S) (where *n* is 1, 2, 4 or 8).

  -OR-
- Touch CONFIGURED PARAMETERS and toggle the desired parameters ON or OFF.
- Touch PREVIOUS MENU twice to define the remaining PRESELECTED key.

**To define the PRESELECTED A and B beds:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch PRESELECTED RECORDINGS.
- Touch the key to be defined (PRESELECTED A or PRESELECTED B).
- Touch SELECT BED.
- Select ALL SUBNETS.

  -OR-
- Select THIS SUBNET.

  -OR-
- Select THIS MONITOR.
- Touch PREVIOUS MENU twice to define the remaining PRESELECTED key.

**To print preselected recordings:**

- Touch RECORD twice.
- Touch RECORD PRESELECTED A or RECORD PRESELECTED B.

# Paper Out Conditions

**Caution:**

- **While printers are offline or out of paper, they ignore any new alarm that normally initiates a recording. Therefore, no alarm or requested recordings go into a queue.**
- **Removing a bedside or system printer module from the monitor to load paper causes an immediate loss of pending print requests.**

All printers signal a paper-out condition by periodically sounding a tone. The PrintMaster beeps every 15 seconds when there is no paper in the paper drawer or the paper drawer is not loaded. In addition, some module printers flash the PAPER OUT light, and the system printers display a *LOCAL PRINTER PAPER OUT* message. On the SL2400/SL2600 printer, the PAPER OUT tone does not sound if the local alarm tone key is set to OFF.

After reloading paper in the system printer module, the paper-feed mechanism ejects a sheet of paper to verify proper paper feeding. For the paper-feed mechanism to function, you must leave the printer power ON while you are loading paper.

# Vitals Report (SL2400/SL2600 monitors only)

**The Vitals Report:**

- Provides a manual report of selected parameter data on 50 mm roll paper.
- Only prints to the monitor's internal printer.

Be sure to choose the data interval, the start time, and the parameters you wish to include on the report before printing.

## Data Interval

Data can be printed at any of the available time intervals (1, 2, 3, 5, 10, 15, 30, and 60 minutes) and, optionally, whenever an NIBP reading is available (NIBP ON). If you select NIBP ON, you are not required to select an interval. If you do not choose an interval or NIBP ON before printing, the message *VITALS REPORT ERROR* prints.

## Start Time

The report can include vital sign measurements taken in the past 1, 2, 4, 8, 12, or 24 hours.

## Select Parameters

You must select the parameters you wish to have included in the report. If you choose a vital sign for which no data is available, then **???** appears on the report. *Figure 9-8* shows an example of a vitals report. The blank **Notes** column appears in every report.

| Time | HR bpm | Resp BPM | Temp 1 C | Notes |
|---|---|---|---|---|
| 07:50 | 74 | 18 | 37.8 | |
| 07:52 | 74 | 18 | 37.8 | |
| 07:54 | 54 | 13 | 37.8 | |
| 07:56 | 54 | 13 | 37.8 | |

*Figure 9-8: Vitals report*

**To define the details of a report:**

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Touch VITALS SETUP.
- Touch DATA INTERVAL and select an interval for the report history.
- Touch PREVIOUS MENU.
- Touch START TIME and select a time period for the report history.
- Touch PREVIOUS MENU.
- Touch SELECT PARAMETERS and select the parameters you wish to include in the report.
- Touch PREVIOUS MENU.

**To print a Vitals Report:**

- Touch VITALS SETUP and then touch PRINT VITAL SIGNS.

  -OR-
- Touch RECORD twice and then touch PRINT VITAL SIGNS.

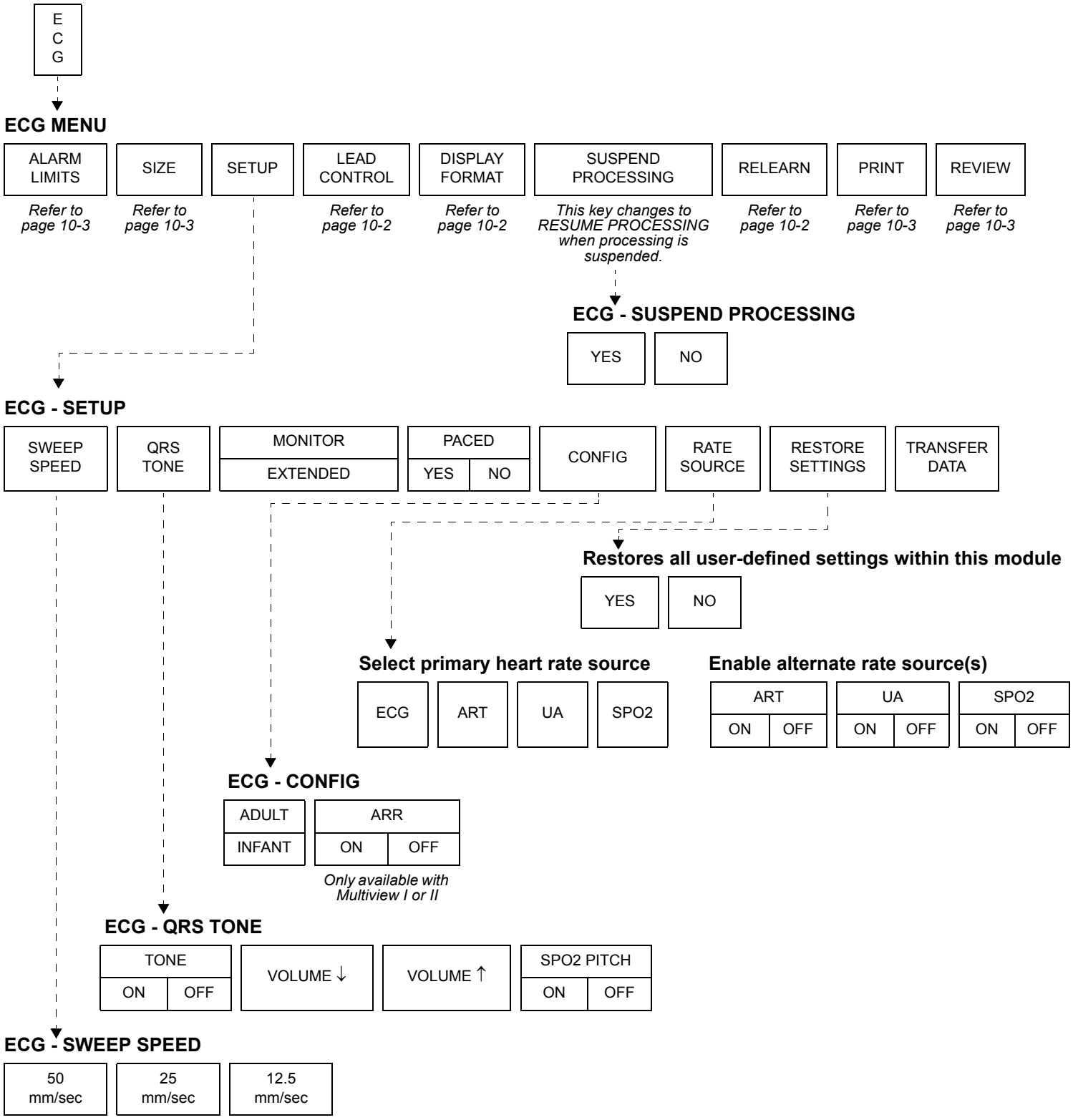
# Printing Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Message PAPER OUT appears** | ■ Printer is out of paper. | ■ Load paper properly and verify that the printer door or printer tray is closed. |
| | ■ Printer door is open. | |
| | ■ Paper was loaded improperly. | |
| **Printer fails to print self-test data or page** | ■ Failed internal diagnostics. | ■ Notify your biomed or a Spacelabs Healthcare field service engineer. |
| **Message UNABLE TO RECORD THE REQUESTED CHANNEL appears** | ■ Printer not ON. | ■ Toggle PRINTER ON/OFF key. |
| | ■ Printer not selected by a system administrator. | ■ Check with your hospital biomed or system administrator. |
| | ■ Printer is out of paper. | ■ Load paper. |
| **CONTINUOUS RECORD key is not displayed** | ■ Menu appears at the bottom of the display. | ■ Touch NORMAL SCREEN, then touch RECORD. |
| **Thermal printer recordings are blank** | ■ Z-fold or roll paper is loaded upside down. | ■ Reload paper correctly. |

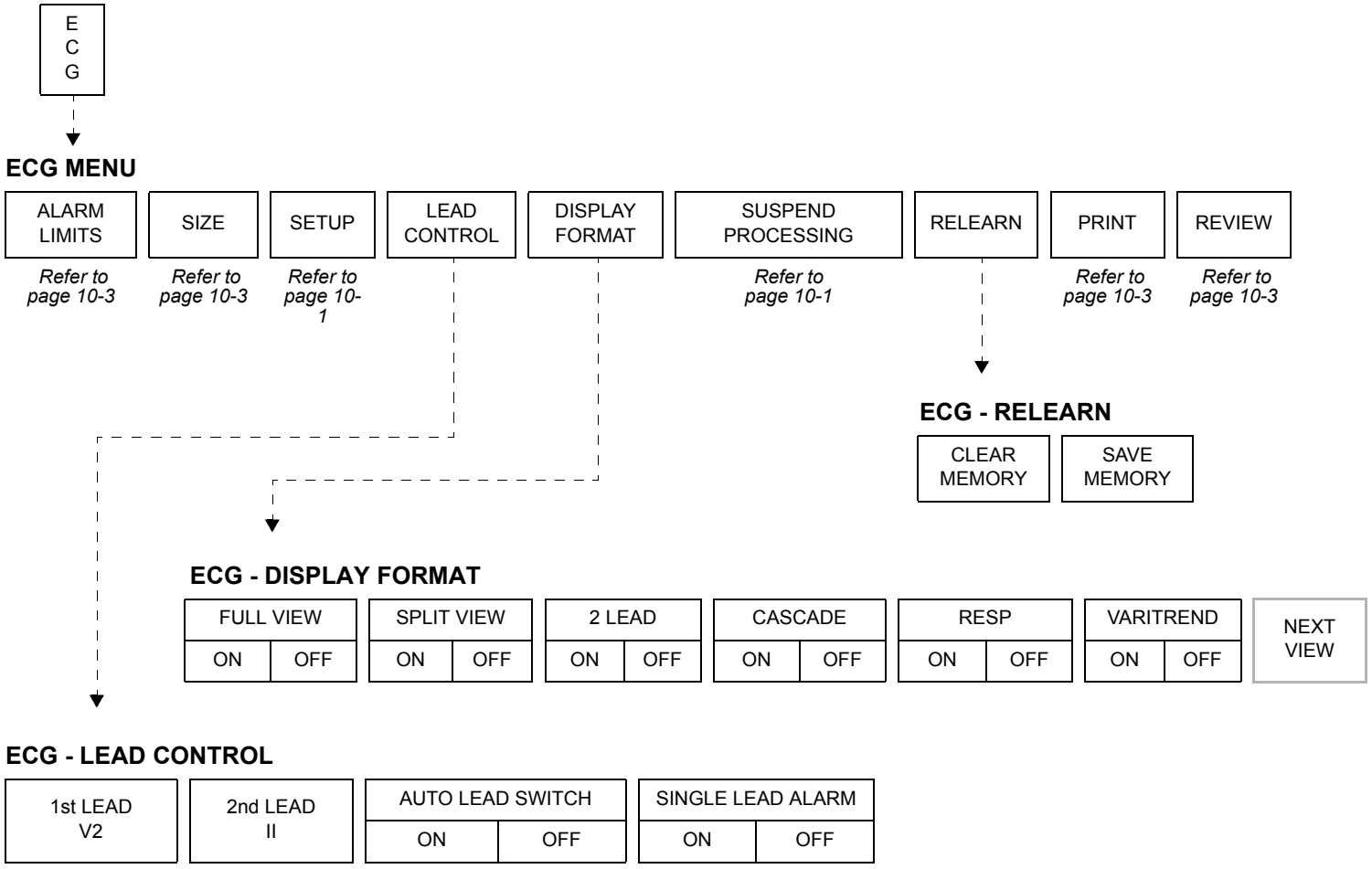
# ECG

## Directory of Keys

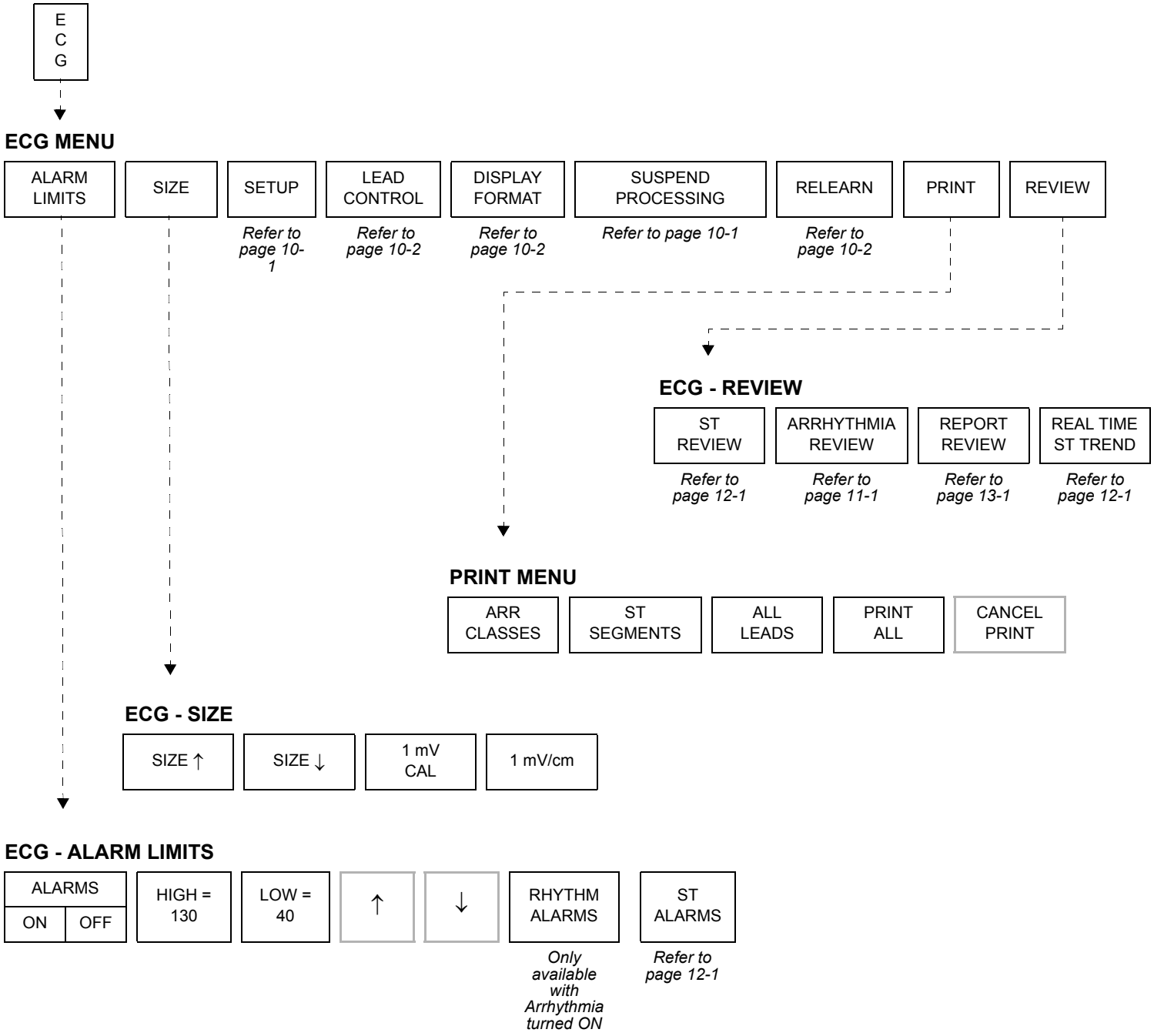
### Setup



## Additional Functions



# Alarms, Size, Printing, and Review



# ECG

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## Overview

The ECG function provides a means for continuous monitoring of electrocardiographic signals. It can detect abnormal cardiac rhythms, including life-threatening arrhythmias such as asystole, ventricular fibrillation, and ventricular runs. ECG monitoring is always performed on two leads.

The monitor's input circuits are protected for use with electrosurgical equipment and defibrillators. Sensors may remain attached to the patient during defibrillation or while an electrosurgical unit is in use. However, the readings may be inaccurate during and shortly after use of such equipment. Cardiac pacemakers or other electrical stimulators do not affect and are not affected by operation of this unit.

The basic ECG software provides alarms for high and low heart rates, for ventricular fibrillation, and for asystole.

The **Multiview I** option provides enhanced arrhythmia detection and alarm capability. In addition to the detection and alarm capabilities of the basic ECG software, Multiview I also detects ventricular runs, ventricular couplets, isolated ventricular beats, atrial fibrillation, pauses, and paroxysmal supraventricular tachycardias (PSVTs).

The **Multiview II** option offers storage capabilities and review. Arrhythmia episodes, as well as dominant and paced rhythms, can be reviewed in a convenient class-based presentation or as trends. Individual events can be edited and printed.

Diagnostic ECG meets all the requirements and standards for electrocardiographic devices. It provides the ability to obtain a diagnostic 12-lead report as a function of the monitoring system. The 12-lead report is a set of diagnostic-quality electrocardiographic waveforms that accurately represent both the detailed cardiac cycle and the cardiac rhythm. Refer to *12-Lead Diagnostics* on page 13-3 for additional information.

**The ECG function:**

- Detects and displays a waveform representing each cardiac cycle.
- Determines lead configuration options.
- Displays the heart rate (heart rate is computed from an average of eight beats, with a provision for being immediately updated should it change suddenly).
- Detects pacemaker pulses.
- Initiates ECG-related alarms when limits are violated.

***Note:***

*To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

You can display ECG waveforms for multiple leads. A message on the display identifies lead faults. If automatic lead switching is enabled, the system automatically switches to another appropriate lead to continue monitoring in the event of a lead fault.

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to ECG. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

# ECG Setup

**An alarm sounds and the CHECK SETUP key appears in the ECG waveform area when any of the following occurs:**

- The monitor is powered ON.
- A monitor reset occurs.
- An ECG module is inserted.

Touch the CHECK SETUP key to dismiss and silence the alarm. Verify that the system configuration (for example, alarm limits or lead selection) is appropriate before you begin, or resume, monitoring.

***Note:***

*The CHECK SETUP key does not appear when the Check Setup feature is disabled, and its associated alarm tone does not sound. Contact your system administrator to enable this feature.*

ECG monitoring begins when the system detects a signal via connection of an ECG patient cable to the module or by installation of a battery into a telemetry transmitter.

**ECG monitoring requires the following minimum conditions:**

- ECG electrodes must be properly attached to the lead wires.
- The lead wires must be properly attached to the patient cable or the telemetry transmitter.
- The patient cable must be connected to the module.
- The module must be connected to a monitor that is powered ON.

**Telemetry ECG monitoring requires the following additional minimum conditions:**

- The telemetry transmitter must have a functional battery.
- The telemetry receiver module must be:
  - Connected to a monitor that is powered ON.
  - Configured to the same channel number as its corresponding telemetry transmitter. Refer to *Setting up Telemetry Monitoring* on page 18-15 for additional information.
  - Connected to a Spacelabs Healthcare diversity antenna.

## Patient Preparation and Electrode Application

Use silver/silver-chloride electrodes or their equivalent, and always connect all electrodes required for a particular lead. Missing electrodes may result in the loss of the ECG waveform.

***Note:***

*Use only Spacelabs Healthcare-recommended electrodes. Some electrodes may polarize and create large offset potentials. This can compromise recovery time after application of defibrillator pulses. Squeeze-bulb electrodes, commonly used for diagnostic ECG recordings, may be particularly vulnerable to this effect.*

Noise on ECG signals, especially noise that resembles actual cardiac waveforms, is a frequent cause of false alarms. Some of this noise may be because of electrode positioning, patient movement or intermittent signal connections (either of electrode to skin or of lead wires to electrodes). You can eliminate some of this noise (and many of these false alarms) by paying careful attention to skin preparation and electrode application.

A patient cable or telemetry transmitter is usually color-coded to match the color of the lead wires. (*Table 1* on page 10-8 lists electrode color and lead identifier codes.)

**To set up ECG monitoring:**

When attaching lead wires to the patient cable or telemetry transmitter, use the color coding and/or lead identifier code to ensure that the correct connections are made.

Most ECG electrodes are a column of conductive gel that is surrounded by an adhesive surface. The condition of the electrode's gel column directly affects the quality of the ECG signal. For example, more noise appears on the ECG signal if gel is displaced (or air is trapped) when you apply an electrode to the patient. Key points to remember include:

- Before using electrodes, verify that they have not expired and that the conductive gel is not dry. Replace the electrodes if necessary.
- Always attach the electrode to its lead wire before applying the electrode to the patient (refer to *Figure 10-1*). Do not apply pressure directly over the electrode's gel column.
- Press firmly around the outer edge of the electrode's adhesive surface to ensure that the electrode is securely attached to the patient.

- To minimize muscle artifact, place electrodes over flat, non-muscular areas of the body (refer to *Figure 10-2* and *Figure 10-3*). This is important for telemetry patients who are usually ambulatory.
- After electrodes and lead wires are attached, add a stress loop (a loop of lead wire taped close to its electrode) to minimize stress or pulling on the electrode itself. This will improve ECG signal quality, particularly for ambulatory patients.

***Note:***

*Spacelabs Healthcare recommends that electrodes be replaced after 24 to 48 hours of use.*

**To prepare the patient:**

- Wash the area with soap and water.
- If necessary, shave the area where you plan to position the electrodes.
- Clean the skin with alcohol.
- Dry the skin thoroughly.
- Abrade the skin.

**To apply ECG electrodes:**

- Attach an electrode to a lead wire.
- Apply the electrode to the patient's skin.

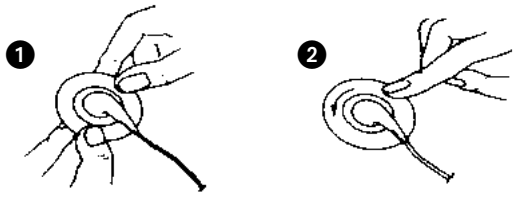



*Figure 10-1: Electrode application*

1. Attach the electrode to the lead wire.
2. Apply the electrode to the skin.

*Table 1: Electrode Color and Identifier Codes*

| AAMI Electrode Identifier | AAMI Color Code | Electrode Placement | IEC Electrode Identifier | IEC Color Code |
|---|---|---|---|---|
| RA | White | Right Arm | R | Red |
| LA | Black | Left Arm | L | Yellow |
| LL | Red | Left Leg | F | Green |

*Table 1: Electrode Color and Identifier Codes (Continued)*

| AAMI Electrode Identifier | AAMI Color Code | Electrode Placement | IEC Electrode Identifier | IEC Color Code |
|---|---|---|---|---|
| RL | Green | Right Leg | N | Black |
| V1 | Brown/Red | 4th Intercostal - Right Sternum | C1 | White/Red |
| V2 | Brown/Yellow | 4th Intercostal - Left Sternum | C2 | White/Yellow |
| V3 | Brown/Green | Midway Between V2 and V4 | C3 | White/Green |
| V4 | Brown/Blue | 5th Intercostal - Left Midclavicular | C4 | White/Brown |
| V5 | Brown/Orange | Left Anterior Axillary Line at V4 | C5 | White/Black |
| V6 | Brown/Violet | Left Midaxillary Line at V4 | C6 | White/Violet |
| C | Brown | Chest | C | White |

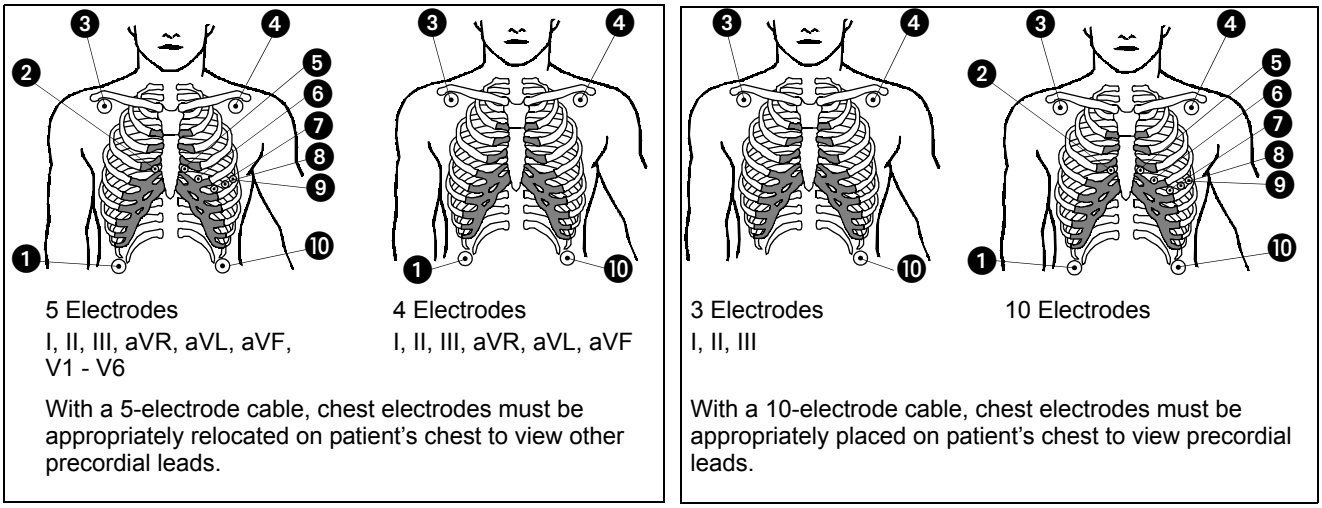
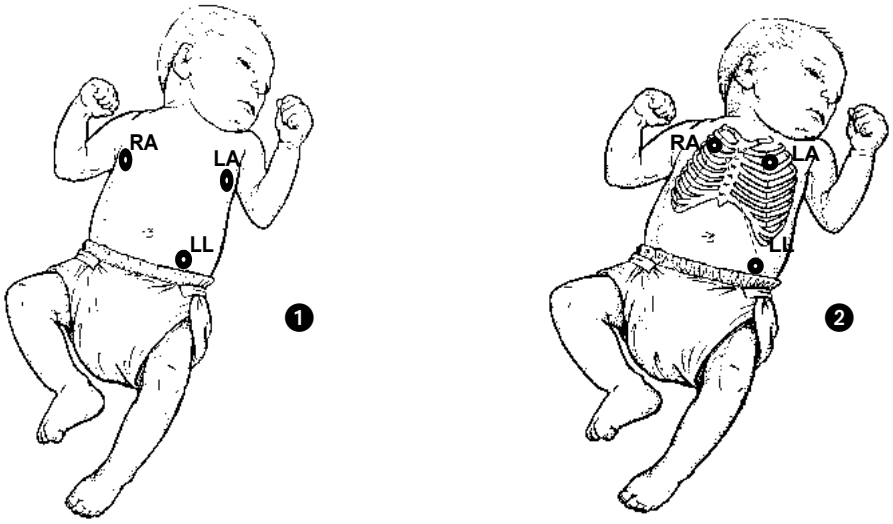

5 Electrodes
I, II, III, aVR, aVL, aVF, V1 - V6
4 Electrodes
I, II, III, aVR, aVL, aVF
With a 5-electrode cable, chest electrodes must be appropriately relocated on patient's chest to view other precordial leads.
3 Electrodes
I, II, III
10 Electrodes
With a 10-electrode cable, chest electrodes must be appropriately placed on patient's chest to view precordial leads.

*Figure 10-2: Adult electrode placement*

| | | | |
|---|---|---|---|
| ❶ | RL | ❻ | V3 (C3) |
| ❷ | V1 (C1) | ❼ | V4 (C4) |
| ❸ | RA | ❽ | V5 (C5) |
| ❹ | LA | ❾ | V6 (C6) |
| ❺ | V2 (C2) | ❿ | LL |




1. Maximum Impedance Change

   Position RA and LA electrodes at the nipple level, anterior axillary line. Position LL below the diaphragm and preferably below the umbilicus.

2. Alternate Method

   Position RA and LA electrodes at the 2nd intercostal space, midclavicular line. Position LL below the diaphragm, preferably below the umbilicus.

*Figure 10-3: Infant electrode placement*

# Display Detail

***Note:***

*For telemetry display information, refer to Display Detail on page 18-12.*

**Your ECG display view may differ from the illustrations in this section, depending on the following:**

- The type of monitor you are using.
- The options in your module.
- Which functions you have enabled.
- The patient type selected.

Multiple ECG waveforms can be displayed at a bedside monitor by selecting either FULL VIEW, SPLIT VIEW, 2nd LEAD, or CASCADE.

A second waveform zone can display either a second ECG lead or a cascaded waveform from the first ECG zone (both cannot be displayed simultaneously). Data in a cascaded ECG waveform wraps from the first waveform zone into the second waveform zone to display 12 seconds of data for the selected lead.

While the cascaded waveform is displayed, the text in the parameter key for the second zone is STOP. Touching the STOP key freezes the waveform for viewing. While the display is frozen, the text in the key is START. Touching the START key resumes the waveform.

**To display 6 or 12 leads (requires a 12-lead cable):**

- Touch ECG.
- Touch DISPLAY FORMAT.
- Touch SPLIT VIEW / ON or FULL VIEW / ON.

**To display 2 leads:**

- Touch ECG.
- Touch DISPLAY FORMAT.
- Touch 2nd LEAD / ON.

**To cascade the ECG waveform:**

- Touch ECG
- Touch DISPLAY FORMAT.
- Touch CASCADE / ON.
- Touch STOP to freeze the ECG waveform.
- Touch START to restart the waveform.

The examples shown in *Figure 10-4*, *Figure 10-5*, and *Figure 10-6* have arrhythmia and ST analysis turned ON.

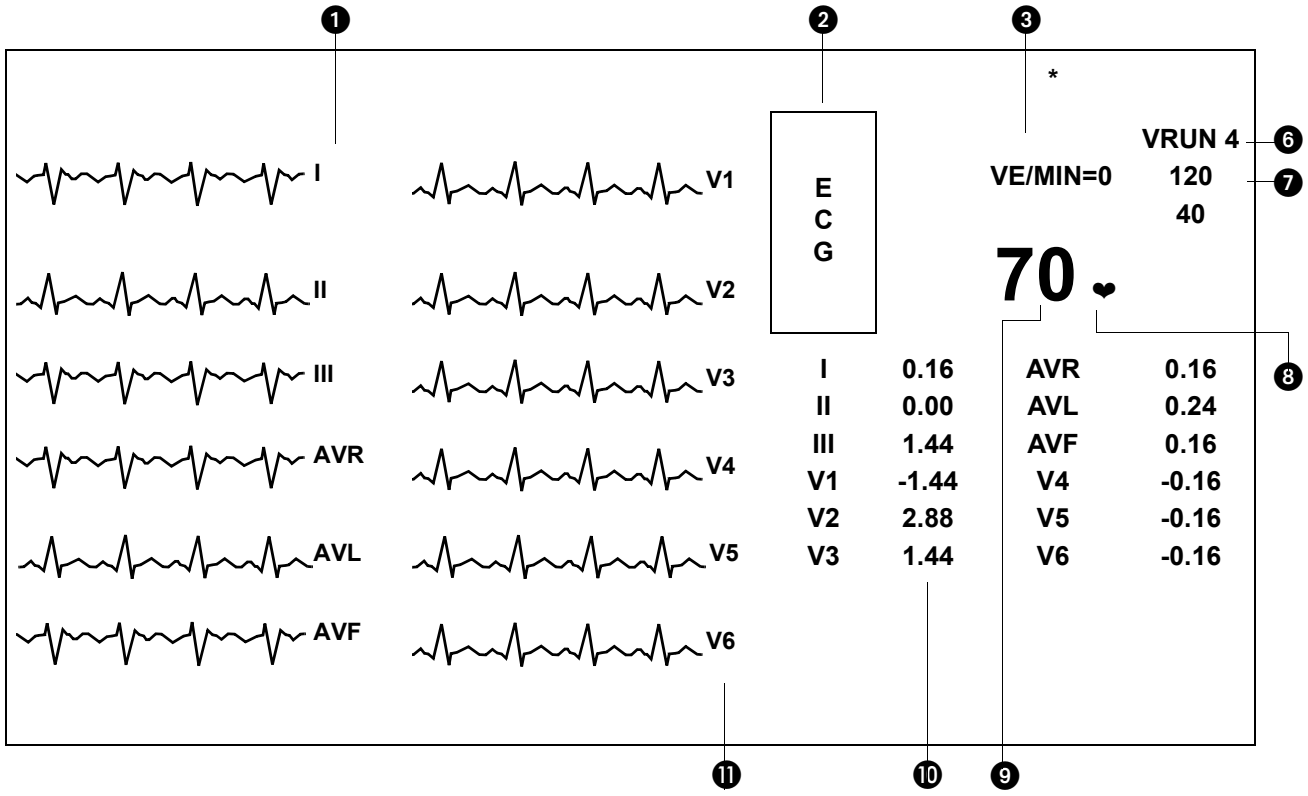



*Figure 10-4: Full-view display, bedside monitor*

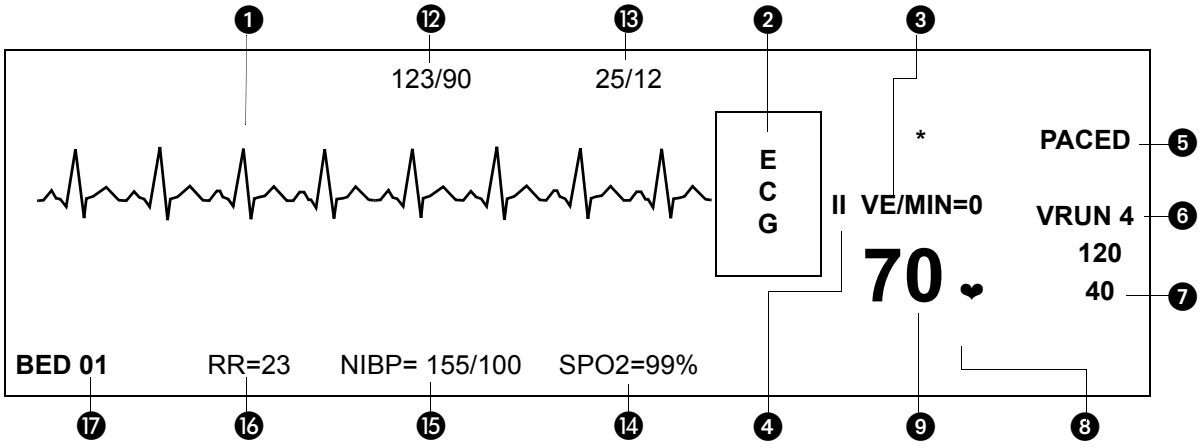



*Figure 10-5: Central monitor*

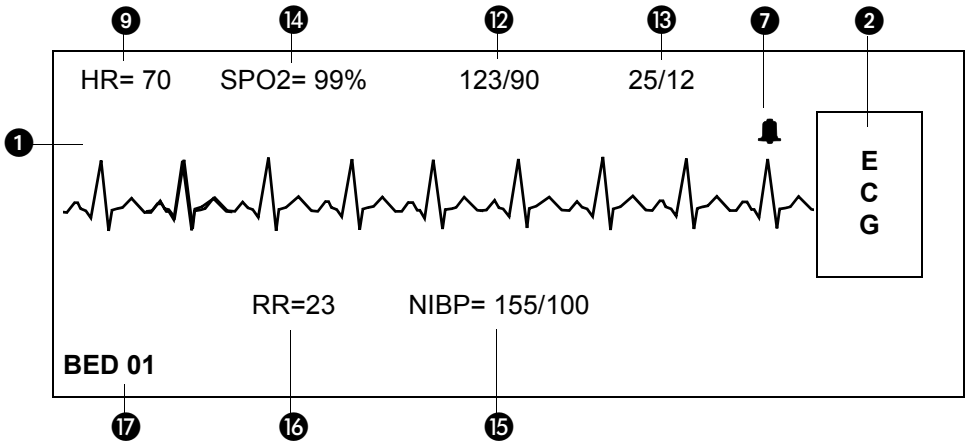



*Figure 10-6: Split-view display, central monitor*

1. ECG waveform for first lead
2. ECG parameter key
3. VEs-per-minute counter *
4. Lead indicator
5. PACED mode indication (pacemaker detection is enabled)
6. Ventricular run alarm limit *
7. ECG rate alarm limits (split-view central monitors display a bell symbol when alarms are enabled)
8. QRS indicator (flashes once per detected beat)
9. Current heart rate
10. ST Segment levels
11. ECG full-view display
12. Arterial pressure (central monitors only)
13. Pulmonary artery pressure (central monitors only)
14. $SpO_2$ level (central monitors only)
15. Noninvasive blood pressure (systolic/diastolic) (central monitors only)
16. Respiration rate (central monitors only)
17. Bed/patient ID (central monitors only)

* *Only appears with the Multiview I or II option in ADULT mode with Arrhythmia detection enabled.*

***Warning:***

***Parameters shown in the ECG display zone in ENHANCED VITAL SIGNS mode do not generate an alarm at the central monitor. Only parameters set via the ALARM WATCH mode will generate an alarm at the central monitor, as set up by the system administrator.***

***Note:***

*If the Enhanced Vital Signs display feature is enabled, you can view $SpO_2$, respiration rate, and noninvasive pressure in the ECG zone on central or remote bedside monitors. However, alarm status information for these parameters does not appear.*

# Selecting ADULT or INFANT Mode

The ECG function provides both ADULT and INFANT operational modes. ECG alarm limits are set based on your selection of ADULT or INFANT. For ECG detection, the QRS amplitude must be at least 0.20 mV in an adult and 0.15 mV in an infant.

**Caution:**

**When INFANT is selected, alarm activation for ECG and respiration can be delayed for up to three minutes. Closely observe the patient during this period.**

**To specify the patient type:**

- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ADULT or INFANT.

# Monitoring Patients with Pacemakers

When monitoring a patient with a pacemaker, the Paced feature prevents pacemaker pulses from being counted as actual beats. Specialized circuitry removes the pacemaker pulses from the ECG signal and replaces them with pacemaker flags.

**To monitor patients with pacemakers:**

- Touch ECG.
- Touch SETUP.
- Select PACED / YES.

Permanent transvenous pacemakers employing a bipolar lead system can obtain a capture of the cardiac muscle at a much lower current than those with unipolar lead systems. For optimal paced rhythm detection, the pacemaker pulse and QRS complex must be of sufficient voltage.

To determine if the monitor is correctly detecting the pacemaker pulses, verify that the Paced feature is activated. Each paced beat should have a pacemaker flag of a contrasting color superimposed on the ECG waveform at the appropriate point prior to the QRS complex. If flags are not consistently observed, cycle through the available leads to find a better lead, or reposition electrodes to optimize pacemaker detection. Check the amplitude of the QRS complex by inserting a 1-mV calibration pulse into the ECG waveform (refer to *Adjusting Waveform Size* on page 10-20).

***Warning:***

***Some rate-adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.***

***Note:***

- *To select the optimal leads for monitoring patients with pacemakers, cycle through the available leads. If pacemaker pulses are not detected, or if the heart rate is incorrectly counted, select another lead or change electrode position.*
- *In telemetry monitoring, pacemaker pulses are detected on Lead II.*
- *If the interval between the pacemaker pulse and the QRS complex is greater than 150 milliseconds, the beat is considered to have originated in the atria and is not classified as a paced beat.*
- *Refer to Warnings and Cautions on page 31-6 for cautionary disclosures related to defibrillators (including implantable cardiac defibrillators), pacemakers, and electrosurgical activity.*

## Verifying the Capture Threshold

When using temporary transvenous pacemakers, verify the pacemaker's capture threshold on a regular basis (refer to your hospital protocol for frequency and procedure). The pacemaker flag that is substituted by the monitor does not represent the true amplitude of the detected pacemaker pulse.

**To verify the capture threshold:**

1 Temporarily disable the Paced feature.

2 Switch the display mode to EXTENDED. Changing the sweep speed to 50 mm/sec improves visualization of the pacemaker pulse amplitude.

3 Return to the MONITOR mode.

4 Reactivate the PACED mode.

5 Reset the desired sweep speed.

Refer to *Changing the Display Resolution* on page 10-22 for additional information about the MONITOR/ EXTENDED key.

**To verify the capture threshold:**

- Touch ECG.
- Touch SETUP.
- Touch PACED / NO.
- Touch EXTENDED.
- Touch SWEEP SPEED.
- Touch 50 mm/sec.
- Perform the capture threshold verification procedure according to your protocol.
- Touch ECG.
- Touch SETUP.
- Touch PACED / YES.
- Touch MONITOR.
- Touch SWEEP SPEED.
- Select the desired speed.

# Enabling and Adjusting Alarms

**Events that can cause an ECG alarm include:**

- High or low rate
- Ventricular fibrillation (VFIB)
- Asystole

*Table 2* on page 10-18 describes the conditions that may initiate an alarm.

**When arrhythmia detection is enabled, additional conditions that can cause an alarm include:**

- Ventricular ectopy
- Atrial fibrillation (AFIB)
- Supraventricular tachycardia (PSVT)
- Pauses

*Table 3* on page 10-19 describes these additional conditions. Refer to *Arrhythmia* on page 11-3 for details concerning arrhythmia alarms. Refer to *ST Analysis* on page 12-3 for details concerning ST alarms. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To adjust rate alarms:**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch HIGH = or LOW =.
- Use the arrow keys to adjust.

***Warning:***

- ***If ECG monitoring is interrupted and subsequently resumed during an asystole event, then five or six seconds will elapse prior to the display of the asystole alarm and the alarm tone.***
- ***If ECG monitoring is initiated during an asystole event, then 10 or 11 seconds will elapse prior to the display of the asystole alarm and the alarm tone.***

***Note:***

*If the alarm limits for high rate, low rate, or VRUN appear in reverse video, then the Alarm Tone, Alarm Recording, and Alarm Watch features are disabled for the indicated alarm.*

During a learn sequence, IN LEARN appears on the monitor display while the system establishes the heart rate and identifies the patient's predominant beat morphology. At the completion of the learn sequence, the rate alarm limits are set based on this learned heart rate (if they were not previously set to FIXED in the Module Configuration Manager). You can adjust these limits up or down as needed.

*Table 2: ECG Alarms*

| Alarm | Cause Of Alarm | Display Indication |
|---|---|---|
| Ventricular Fibrillation | Ventricular fibrillation detected | VFIB ALARM |
| Asystole | More than 5 seconds have elapsed with no QRS detected. | Heart rate 0; flashing low rate limit; ASYSTOLE ALARM |
| High Heart Rate | High limit violated | Flashing high limit and HIGH RATE ALARM |
| Low Heart Rate | Low limit violated | Flashing low limit and LOW RATE ALARM |
| Chan 1 and 2 - Leads Off | One or more of the electrodes for *both* ECG leads is off or loose. There is no power to the module housing (refer to *90491 and 90499 Module Housings — Power Failure* on page 1-7). | No ECG waveform and CHAN 1 and 2 LEADS OFF |
| Chan 1 - Lead Off | One or more of the electrodes for the *first* ECG lead is off or loose | No ECG waveform for CHAN 1 and CHAN 1 - LEADS OFF |
| Chan 2 - Lead Off | One or more of the electrodes for the *second* ECG lead is off or loose | No ECG waveform for CHAN 2 and CHAN 2 - LEADS OFF |

*Table 2: ECG Alarms (Continued)*

| Alarm | Cause Of Alarm | Display Indication |
|---|---|---|
| Rate Source Unavailable | Heart rate is not available from either the primary or any alternate heart rate source | HR UNAVAILABLE |
| Noisy Signal | Excessive noise, artifact, or baseline shift | NOISY SIGNAL |
| Low ECG Voltage | QRS amplitude is between 0.16 and 0.20 mV (adults only) | ECG VOLTAGE TOO LOW |

*Table 3: Arrhythmia Alarms*

| Alarm | Cause Of Alarm | Display Indication |
|---|---|---|
| VE Per Minute | VE per minute count initially equal to or exceeds the VE/MIN alarm setting. | VE/MIN ALARM |
| Couplet | Two consecutive abnormal beats detected and COUPLET ALARM ON/OFF key is set to ON. | COUPLET ALARM |
| Ventricular Run | Number of consecutive abnormal beats equal to or exceeds the VRUN LEN alarm setting. Also, the rate of the beats in the run must be higher than the VRUN BPM set in Module Configuration Manager. | V RUN ALARM |
| Atrial Fibrillation | Atrial fibrillation detected. | A FIB ALARM |
| Supraventricular Tachycardia | Supraventricular tachycardia detected and PSVT ALARM ON/OFF is set to ON. | PSVT ALARM |
| Pause | R-R interval length exceeds limit set by pause alarm key and PAUSE SEC key is set to ON. | PAUSE ALARM |

# Selecting ECG Leads

When you change lead selections, the new waveform displays and the learn sequence is automatically initiated. If you change lead selections while processing is suspended, the module initiates the learn sequence when you resume processing. Changing your selection for the first lead may change the selection for the second lead.

When you select a precordial lead, a message appears, describing the proper location for the chest electrode. For example, if you select V1, the message *(C) 4TH INTERCOSTAL SPACE, RIGHT STERNAL BORDER* appears. No message appears when you choose to display a limb or augmented lead (for example, I, II, III, AVR, AVL, or AVF).

***Warning:***

***ECG alarms for ventricular fibrillation and asystole remain active while the patient's rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, and other arrhythmias are not reactivated until the learning process ends.***

**To change the lead selection:**

- Touch ECG.
- Touch LEAD CONTROL.
- Touch 1st LEAD or 2nd LEAD.
- Select lead.

# Adjusting Waveform Size

You can increase or decrease the display size of the ECG waveform without affecting the signal gain.

When you touch the 1 mV/cm key, the ECG waveform size is set to one millivolt per centimeter. This standardizes the waveform to aid in accurately viewing QRS complexes for ST segment deviation.

***Note:***

*Waveform sizes for all leads are adjusted simultaneously when you display multiple ECG leads in either SPLIT-VIEW or FULL-VIEW mode.*

**To adjust waveform size and/or check the ECG amplitude:**

- Touch ECG.
- Touch SIZE.
- Use the arrow keys to adjust.

  -OR-
- Touch the 1 mV/cm key to standardize.

Touching the 1 mV CAL key inserts a one-millivolt amplitude calibration pulse into all ECG waveforms. Use this calibration pulse as a reference to determine whether the amplitude of the ECG waveform exceeds the minimum voltage threshold.

# Adjusting Sweep Speed

The sweep speed determines the speed at which the ECG waveform moves across the display. Changes to SWEEP SPEED affect all displayed ECG waveforms.

***Note:***

*Changing the ECG sweep speed may also change the speed of the invasive pressure waveforms. Refer to Adjusting Waveform Size and Sweep Speed on page 20-8 for additional information.*

**To adjust the sweep speed:**

- Touch ECG.
- Touch SETUP.
- Touch SWEEP SPEED.
- Select the desired speed.

# Adjusting Tones

## QRS Tone

The QRS tone is the sound the monitor generates with each detected R wave. When the QRS tone is ON, you can adjust the volume and select to modulate the tone with the current $SpO_2$ value.

**To set the QRS tone:**

- Touch ECG.
- Touch SETUP.
- Touch QRS TONE.
- Touch TONE / ON.
- Use the VOLUME arrow keys to adjust the volume.

## $SpO_2$ Pitch

The monitor uses the default pitch for the QRS tone when the $SpO_2$ pitch tone is OFF. When you enable the $SpO_2$ pitch tone, the monitor modulates the pitch of the QRS tone higher or lower depending on the current $SpO_2$ value. When the QRS tone is OFF, the $SpO_2$ pitch modulation automatically turns OFF.

# Changing the Display Resolution

The MONITOR/EXTENDED key determines the display resolution of the ECG waveforms.

- MONITOR mode reduces the frequency range to filter out more noise for better viewing.
- EXTENDED mode displays a broader frequency range with more noise.

| Key | Telemetry | Non-telemetry |
|---|---|---|
| MONITOR | 0.5 to 30 Hz | 0.5 to 40 Hz |
| EXTENDED | 0.05 to 30 Hz | 0.05 to 150 Hz |

***Note:***

- *If you change the display resolution, you do not change the waveform bandwidth used to analyze the ECG signals for arrhythmia and ST segment level.*
- *ECG modules sample at a fixed rate of 896 times per second to accurately capture, analyze, and display cardiac activity.*
- *Telemetry ECG transmitters sample at 120 times per second to capture and display cardiac activity.*

**To change the display resolution:**

- Touch ECG.
- Touch SETUP.
- Select MONITOR or EXTENDED.

# Selecting Primary and Alternate Heart Rate Sources

You can select a primary rate source and enable alternate rate sources. Rate sources include ECG, ART (arterial pressure), UA (umbilical artery), and $SpO_2$.

If you enable one or more alternate sources, a heart rate appears (if available) from either the primary or an alternate source. If you do not enable any alternate sources, a heart rate will only appear if the primary rate source is available. If a heart rate is not available from any source, the message *HR UNAVAILABLE* appears in the ECG waveform zone and question marks (**???**) replace the rate value.

**Caution:**

**When you use an alternate heart rate source, Cardiovascular Artifact (CVA) detection is disabled for the respiration channel.**

***Note:***

- *If you use ART as an alternate heart rate source, Spacelabs Healthcare recommends setting up each monitor with only one arterial pressure channel.*
- *Use of $SpO_2$ as the primary heart rate source is not recommended, because $SpO_2$ is a frequent source of false alarms.*

**To select a primary heart rate source:**

- Touch ECG.
- Touch SETUP.
- Touch RATE SOURCE.
- Select the desired primary rate source (ECG, ART, UA, or SPO2).

**To enable alternate rate sources:**

- Touch ECG.
- Touch SETUP.
- Touch RATE SOURCE.
- Set the desired alternate source(s) to ON (ECG, ART, UA, and/or SPO2).

# Suspending/Resuming ECG Processing

When you touch YES in the **Suspend Processing** menu, ECG and respiration waveforms continue to display, but no processing occurs. If you touch NO, then the display returns to the **ECG** menu without affecting ECG and respiration processing.

**To suspend ECG processing:**

- Touch ECG.
- Touch SUSPEND PROCESSING.
- Touch YES.

**To resume ECG processing:**

- Touch ECG.
- Touch RESUME PROCESSING.
- Touch YES.

**When ECG processing is suspended:**

- The SUSPEND PROCESSING key changes to RESUME PROCESSING.
- The message *ECG PROCESSING SUSPENDED* appears in the ECG waveform zone. In modules with the respiration option, the message *RESP PROCESSING SUSPENDED* appears in the respiration waveform zone.
- Question marks replace the heart rate immediately and replace the ST segment value after 30 seconds. If an alternate heart rate source is available, the new heart rate is displayed. Question marks (**???**) continue to display for the ST segment value.
- Patient Data Logger displays questions marks (**???**) for both heart rate and ST segment value.

- The message *ECG ALM OFF* replaces the alarm limits, and keys in the **ECG Alarm Limits** menu are disabled (if no alternate rate source is available).
- For multiparameter telemetry, $SpO_2$ and/or NIBP alarm surveillance is still active if already enabled by the user. Alarm messages related to NIBP and $SpO_2$ prevent the ECG *PROCESSING SUSPENDED* message from appearing.

# Printing ECG Data

**All printouts of ECG data are annotated with the following:**

- Bed identification
- Time and date of printout
- Lead designator

Depending on the type of printer, the ALL LEADS recording can be printed on a single page or as consecutive two- or four-channel recordings. Waveform data are printed for 6.25 seconds for all available leads.

Refer to *Acquiring and Printing 12-Lead Reports* on page 13-4 for information on printing 12-lead reports.

**To print recordings of all leads:**

- Touch ECG.
- Touch PRINT.
- Touch ALL LEADS.

# Restoring Default Settings

The RESTORE SETTINGS key changes the user-configurable settings for all parameters in the module to the defaults previously stored as user settings (refer to the *Ultraview SL Module Configuration Manager System Administration Guide*, P/N 070-1245-xx). After the default settings are restored, the system initiates a learn sequence. Following the learn sequence, rate, and ST alarm limits are reset.

**To restore default settings:**

- Touch ECG.
- Touch SETUP.
- Touch RESTORE SETTINGS.
- Select YES.

# ECG Problem Solving

**If ECG signal quality is poor (indicated by wandering baseline, excessive noise, or muscle or respiration artifact), try the following solutions:**

- Ensure that silver/silver-chloride electrodes are being used.
- Ensure that the patient's skin is properly prepared.
- Ensure that all electrodes are firmly attached and in good condition.
- Ensure that the electrodes are positioned on a flat, non-muscular area.
- Ensure that lead wires are properly fastened and in good condition.

If these actions fail to resolve the problem, select a different lead.

## Lead Fault Indication

The message *CHECK XX* (where *XX* identifies the failed or missing electrode) appears in the ECG waveform zone if a lead fault occurs.

If automatic lead switching is enabled, another lead is automatically selected so that monitoring is uninterrupted.

A *LEADS OFF* message appears if automatic lead switching is disabled.

## Noise Detection

A *NOISY SIGNAL* message appears in the ECG waveform zone if noise is detected. If both the first and second lead are noisy, the module suspends processing temporarily. If the noise persists for 10 seconds, the system initiates an alarm. The message and alarm cease when the noise disappears.

***Note:***

- *If monitoring is interrupted because of overload or saturation of the input amplifiers, including overload caused by a defibrillator discharge, the ECG waveform is displayed as an out-of-range signal accompanied by a NOISY SIGNAL or HR UNAVAILABLE message. If the overload or saturation condition persists, the ECG waveform is displayed as a flat-line signal accompanied by an ASYSTOLE ALARM message.*
- *If the displayed waveform does not appear noisy, but the NOISY SIGNAL message persists, check all leads for noise before calling a qualified field service engineer.*

## False Alarms

Careful attention to skin preparation and electrode application, especially during setup, will reduce false alarms.

**If false alarms occur, check for the following:**

- Excessive noise on the signal (the most common cause of false alarms). Electrodes that are placed incorrectly over muscles, or a poor lead connection, can cause significant noise when the patient moves.
- Heart rate limits set too close to patient's heart rate. Adjust the limits as necessary.

- ECG amplitude drops below the R-wave detection threshold level. This causes false low rate alarms. Reposition the electrodes to obtain a QRS amplitude of at least 0.20 mV for adults and at least 0.15 mV for infants.
- QRS frequency components and shape are unsatisfactory for accurate beat detection and classification. Make necessary changes in electrodes, electrode sites, or lead selection to restore a good signal.
- VFIB resembles previously classified abnormal beats. This may cause VFIB to be detected as a RUN. If this occurs, use the waveform display as the primary indication of the patient's condition.
- The system does not recognize some beats as morphologically different from the learned dominant beat. You may be able to improve performance by changing electrode positions or switching to a lead setting that provides better differentiation between the dominant and abnormal beats.

# ECG Alarm Delays

*Table 4: ECG Alarms*

| Alarm Setting | Alarm Delay |
|---|---|
| Asystole | Less than 2 seconds |
| Ventribular Fibrillation | Less than 9 seconds |
| Heart Rate High | HR change from 35 to 140 bpm, limit 135 bpm<br>Average less than 9 seconds, maximum less than 10 seconds |
| Heart Rate Low | HR change from 140 to 35 bpm, limit 40 bpm<br>Average less than 12 seconds, maximum less than 13 seconds |
| Ventricular Run | Less than 3 seconds |

# ECG Troubleshooting Guide

**Caution:**

**Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **AC noise** | ■ Display resolution is set to EXTENDED mode. | ■ Select MONITOR mode. |
| | ■ Electrodes are dry. | ■ Repeat skin preparation and apply new moist electrodes. |
| | ■ ECG cable is entwined with other electrical devices. | ■ Separate ECG cable from all other cables. |
| **Baseline wanders** | ■ Patient is moving excessively. | ■ Use stress loops to secure lead wires and cable to the patient. |
| | ■ Respiration artifact. | ■ Select another lead or reposition the electrodes. |
| | ■ Electrodes are dry. | ■ Repeat skin preparation and apply new moist electrodes. |
| **Low amplitude ECG** | ■ Skin is improperly prepared. | ■ Abrade skin and reapply electrodes. |
| | ■ Selected lead is not showing the QRS complex with greatest amplitude. | ■ Check the 12-lead ECG to determine a better monitoring lead and/or reposition electrodes. |
| | ■ Electrodes could be positioned too close to bone or muscle mass. | ■ Select another lead or reposition electrodes. |
| **ECG won't learn** | ■ ECG signal is too noisy for initialization. | ■ Improve signal quality by repeating skin preparation and/or repositioning electrodes. |
| | ■ ECG voltage is below threshold. *ECG VOLTAGE TOO LOW* message may appear. | ■ Perform the following steps as needed.<br>1 Check cables, lead wires, and electrodes, then relearn patient rhythm.<br>2 Change lead or reposition electrodes. |

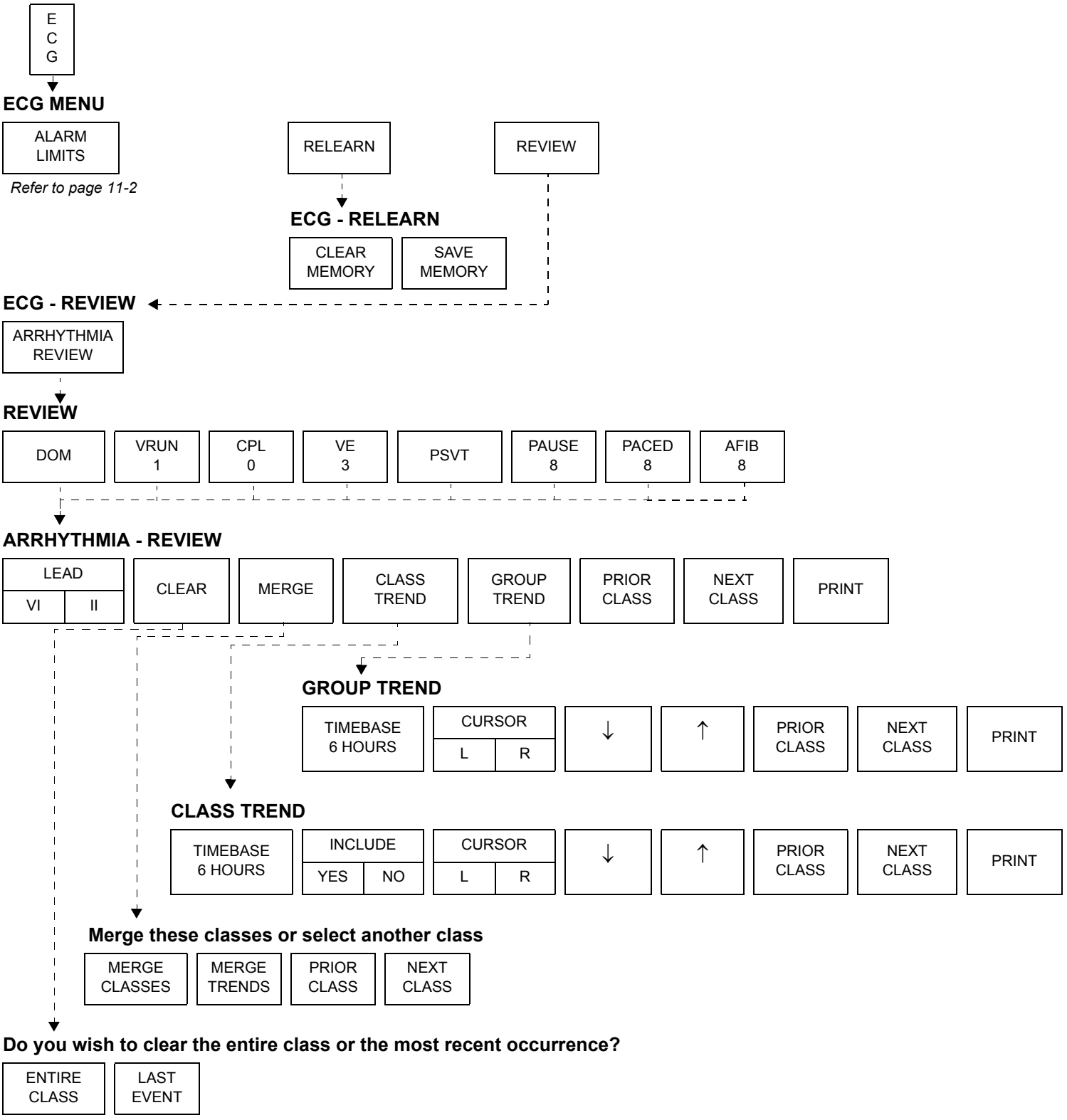
## ECG

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No ECG waveform** | ■ Improper attachment of the ECG cable to the module/transmitter, or leads off. | ■ Remove and then reconnect the ECG cables to the module, or reconnect the leads to the patient cable or transmitter. |
| | ■ Module is not seated into the monitor or remote housing. | ■ Remove and then reinsert the module, or replace the module. |
| **Excessive alarms** | ■ Electrodes are dry. | ■ Repeat skin preparation and apply new moist electrodes. |
| | ■ Alarm limits are set too close to patient's normal heart rate. | ■ Readjust alarm limits. |
| | ■ Excessive interference: patient cable or wires are routed too close to other electrical devices. | ■ Reroute cables and leads. |
| | ■ Excessive patient movement or muscle tremor. | ■ Reposition electrodes and use stress loops to secure lead wires and cable to the patient. |

# Arrhythmia

## Directory of Keys

### Arrhythmia Review

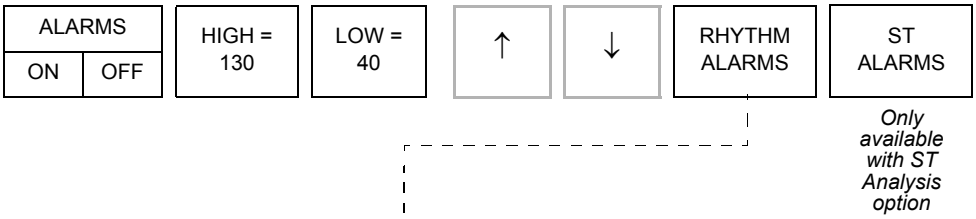


# Alarm Limits

**ECG MENU**




**ECG - ALARM LIMITS**




**ECG - RHYTHM ALARMS**



# Arrhythmia

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## Overview

**Arrhythmia detection and review are capabilities available in the following options:**

The **Multiview I** option provides enhanced arrhythmia detection and alarm capability. In addition to the detection and alarm capabilities of the basic ECG software, Multiview I also detects ventricular runs, ventricular couplets, isolated ventricular beats, atrial fibrillation, pauses, and paroxysmal supraventricular tachycardias (PSVTs).

The **Multiview II** option offers storage capabilities and review. Arrhythmia episodes, as well as dominant and paced rhythms, can be reviewed in a convenient class-based presentation or as trends. Individual events can be edited and printed.

***Warning:***

***Keep patients under close surveillance. Do not rely entirely on the monitor for patient assessment.***

***Note:***

- *No arrhythmia detection system can correctly detect and classify all arrhythmias 100% of the time. Use sound clinical judgment when monitoring patients with arrhythmias.*
- *To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

# Setting Up Arrhythmia Monitoring

With the Multiview I or II option, the ARR ON/OFF key enables or disables arrhythmia detection functions. Arrhythmia detection must be enabled to establish a new dominant waveform (refer to *Relearning the Dominant Waveform* on page 11-7 for additional details).

**To set up arrhythmia monitoring:**

- Set up system and patient for standard ECG monitoring.
- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Ensure ADULT is selected.
- Select ARR / ON.

**To disable arrhythmia detection:**

- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ARR / OFF.

**When you turn arrhythmia detection ON:**

- IN LEARN appears above the ECG waveform in the first zone.
- The RELEARN key is present in the **ECG** menu.
- The RHYTHM ALARMS key is present in the **Alarm Limits** menu.
- ECG alarms are momentarily deactivated until the learn sequence completes.
- Rhythm alarm limits are initialized.

**When you turn arrhythmia detection OFF:**

- IN LEARN appears above the ECG waveform in the first zone.
- No arrhythmia detection features or menus are displayed.
- ECG alarms are momentarily deactivated until the learn sequence completes.
- Rate and ST alarm limits are initialized.

# Classifying Events

*Table 1* describes the arrhythmias detected with the Multiview I or II options.

*Table 1: Classification of Events*

| Type of Class | Defining Characteristics | Max # of Classes Allowed | Type of Waveform Storage (Multiview II only) |
|---|---|---|---|
| DOMINANT * | NA | 1 | Qualifying occurrence (10th) + most recent each minute |
| V FIB | NA | 1 | Six seconds of last occurrence |
| V RUN | Three or more consecutive beats of abnormal morphology | 32 | Six seconds of each occurrence. First in, first out. Saves longest VRun and Pause. |
| COUPLET * | Two consecutive beats of abnormal morphology | 12 | Qualifying occurrence (3rd) + most recent |
| SINGLE VE* | One beat of abnormal morphology | 12 | Qualifying occurrence (5th) + most recent |
| PSVT | Five or more consecutive premature** dominant beats | 1 | Six seconds of last occurrence |
| PAUSE | Defined by the PAUSE ALARM setting | 32 | Six seconds of each occurrence. First in, first out. Saves longest Run and Pause. |
| ASYSTOLE | Absence of QRS for 5 seconds or more | NA | Six seconds of last occurrence stored as a pause when following normal beats. |
| PACED/<br>AV PACED | (PACED) 1 pacemaker spike followed by a QRS (within 150 ms)<br><br>(AV PACED)<br>2 pacemaker spikes followed by a QRS | 1 | First paced beat occurrence each minute (PACED key must be set to YES) |
| A FIB | NA | 1 | Six seconds of last occurrence |

* *Template-forming classes (class trends are only available for template-forming classes).*

** *Prematurity is defined as an instantaneous R-R interval that is 15% premature compared to the average R-R interval and ≤500 ms.*

# Learning and Relearning

## Learning the Dominant Waveform

**During the learn sequence:**

- IN LEARN appears on the monitor display.
- The system determines the heart rate and begins to classify each beat.
- Rate alarms are set based on this learned heart rate (if they have not been previously set to FIXED in the Module Configuration Manager).
- The first non-premature beat that occurs ten times is established as the dominant class.

When the learn sequence is completed, the *IN LEARN* message disappears from the monitor display.

**Examples of actions that initiate a learn sequence are:**

- Power ON
- Module insertion
- Changing patient type (adult/infant)
- Enabling or disabling arrhythmia detection
- Patient admission via the **Admit/Discharge** menu

The system does not classify a paced beat as the dominant class. If the patient is 100% paced and there is no dominant class at the end of the learn sequence, the first single non-paced beat detected five times becomes the dominant class.

## Detecting Ectopic Beats

The system compares each incoming beat with the dominant class. It examines morphology and the intervals between both the previous and the following beats to determine whether the beat matches the dominant. If the system determines that the beat is ectopic, it compares the new beat with each of the abnormal shapes that have been detected since the learn sequence was completed. If the current beat fails to match any of the existing shapes (and after five occurrences), the system classifies it as a new VE class.

## Detecting Paced Beats

Once learning is completed, a Paced class is created when the system detects the first paced beat if the Paced feature is enabled in the **ECG Setup** menu.

**The system identifies two different types of paced beats:**

- **Paced** — indicates ventricular-paced beats (defined as a QRS complex) that are preceded by a single pacemaker pulse.
- **AV-paced** — indicates beats that are preceded by two pacemaker pulses.

The QRS complex must follow the pacemaker pulse within 150 ms for the beat to be classified into either paced class. If the pacemaker pulse precedes the QRS complex by more than 150 ms, the beat may be triggered by an atrial pacemaker and is not classified in either paced class.

## Relearning the Dominant Waveform

You can relearn the dominant rhythm and establish a new dominant at any time during monitoring. After touching the RELEARN key, you can either clear the memory or save the memory. Once a selection is made, the relearn sequence is initiated. During this sequence, ECG alarms are suspended.

**To relearn the dominant waveform:**

- Touch ECG.
- Touch RELEARN.
- Select SAVE MEMORY or CLEAR MEMORY.

***Warning:***

***ECG alarms for ventricular fibrillation and asystole remain active while the patient's rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, ventricular run, couplet, VEs/minute, and supraventricular tachycardia are not reactivated until the learning process ends.***

Select CLEAR MEMORY to clear all arrhythmia and ST segment data and reset the arrhythmia, and ST segment alarms. Upon completion of the learn sequence, ECG alarms are enabled and rate alarm limits are reset.

Select SAVE MEMORY to save all previously acquired arrhythmia and ST segment data. The old dominant is labeled as EXDOMINANT and is stored as a VE class. Once the learn sequence is completed, ECG alarms are enabled and rate alarms are reset. The arrhythmia alarms remain unchanged. If ST segment level alarms are enabled prior to the relearn sequence, they will be reset.

# Automatic Dominant Class Update

The system automatically learns the patient's predominant morphology. It also dynamically updates the dominant class as the patient's morphology changes. The system uses the following rules to update the dominant class:

**A VE class automatically becomes the new dominant class when it occurs:**

- More frequently than 50% of all beats in the previous 60 seconds.
- Three beats more frequently than the current dominant during that period.

The old dominant is put into a VE class and given the status EXDOMINANT. This class can become dominant again and has the same characteristics as any other active class.

The message *NEW DOMINANT* appears above the ECG waveform for 60 seconds after the new dominant is established.

# Display Detail

**The system stores and displays arrhythmia events in two categories (refer to *Figure 11-1*):**

- **Non-template-forming class** — displays a waveform that is 6.25 seconds in length and is representative of the most recent occurrence.
- **Template-forming class** — displays two waveforms:
  - The waveform on the left is 1.25 seconds in length. The arrhythmia that originated the class is centered.
  - The waveform on the right is 4.5 seconds in length. The most recent occurrence of the class is centered.

The lead, the frequency, and the time and date of the last occurrence appear to the right of each presentation.



Non-template-forming class example
(PSVT)

**Lead II**

| | |
|---|---|
| Last MINUTE: | 1 |
| Last HOUR: | 1 |
| Last OCCURRENCE: | 04:44 AM<br>18 Jul 2011 |



Template-forming class example
(Couplet)

**Lead VI**

| | |
|---|---|
| Last MINUTE: | 2 |
| Last HOUR: | 6 |
| Last OCCURRENCE: | 04:40 AM<br>18 Jul 2011 |

*Figure 11-1: Arrhythmia waveforms*

# Enabling and Adjusting Alarms

In addition to the basic ECG alarms described in *Enabling and Adjusting Alarms* on page 10-17, the Multiview options provide alarms for:

- Ventricular Runs (VRUN)
- Ventricular couplets (COUPLET);
- Ventricular beats/minute (VE/MIN);
- Atrial fibrillation (AFIB);
- Supraventricular tachycardia (PSVT); and
- Pauses (PAUSE)

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To set or adjust rhythm alarms (arrhythmia detection must be enabled):**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch RHYTHM ALARMS.
- ‘Select an arrhythmia key.
- Use the arrow keys to adjust.
- Touch YES or NO.

***Note:***

*If the alarm limits for high rate, low rate, or VRUN appear as reverse video, it indicates that the Alarm Tone, Alarm Recording, and Alarm Watch features are disabled for the indicated alarm.*

Setting the ventricular run (VRUN) LEN = alarm limit to three or greater initiates a V*RUN ALARM* message when three or more consecutive ectopic beats (at a rate greater than the user-specified limit) occur. You cannot set the **VRUN LEN =** alarm limit to less than three.

# Reviewing Arrhythmias

**To review arrhythmias:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class type for review.
- Select NEXT CLASS or PRIOR CLASS keys to progress through the review.

***Note:***

*Arrhythmia Review functions are only available in modules with the Multiview II option in the ADULT mode. Arrhythmia detection and Review must be enabled.*

## Selecting Arrhythmia Classes

The numeric value for each arrhythmia key indicates the number of occurrences the system has stored. If no occurrences have been detected, the number on the key is 0 and the key is disabled. For classes that only store the last occurrence of that type of arrhythmia (for example, PSVT), no value is displayed. The menu updates as new classes are created.

## Selecting Leads for Review

When you access the **Arrhythmia Review** menu, the LEAD key indicates which leads were being monitored the last time the displayed event occurred. The lead associated with the currently displayed waveform is highlighted. Touch the LEAD key to display the waveform for the other lead.

## Multiple Arrhythmia Classes

The system assigns numbers to each class to distinguish between classes of the same type with different morphologies. The class number is displayed to the right of the class type (for example, VE 1).

The system displays, in sequence, up to 32 different ventricular runs and/or pauses. However, the system always keeps the longest ventricular run or pause. If the system detects one more pause and/or ventricular run than it can store, it replaces the oldest ventricular run or pause with the new one (for example, first in, first out).

## Updating Classes

The system updates the review waveform once each minute for the dominant, paced, and AV-paced classes. Otherwise, it updates it with each occurrence.

# Clearing a Class or Event

When you clear a class, the system removes it from memory.

Touch the ENTIRE CLASS key to clear the displayed class and template from memory and from the trend buffer.

Touch the LAST EVENT key to remove only the most recent occurrence of the displayed class from memory. The LAST EVENT key is only active for VE and COUPLET classes.

**To clear a class or the most recent event in a class:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch CLEAR.
- Select ENTIRE CLASS or LAST EVENT.

**When you clear the most recent event:**

- The most recent occurrence of that class is removed from memory.
- The message *THE LAST OCCURRENCE OF THIS CLASS WAS DELETED* appears in place of the cleared waveform.
- The totals for frequency and last occurrence are updated. The updated information does not appear until you re-display the class.

# Merging Classes or Trends

Merging enables you to take two different classes or trends from the same group and merge them together into a single class. This combines the trend history and time of last occurrence.

**To merge class or trend data:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch MERGE.
- Use PRIOR CLASS or NEXT CLASS to display the two classes you wish to merge.
- Select MERGE CLASSES or MERGE TRENDS.

To combine the data for two recurring arrhythmia classes, merge the classes instead of the trends. Merging classes permits the two classes to be stored and trended together on an ongoing basis.

To combine an active arrhythmia class with an inactive class, merge the trends. An example of an inactive arrhythmia class is the dominant morphology associated with a previous lead selection.

## Merging Classes

When a single morphology is frequently being stored as two different classes, merging the classes makes more disk space available for new classes and saves all arrhythmia data. This can occur if a patient's dominant beat is experiencing frequent changes in polarity or when the electrodes have been repositioned.

At the beginning of merging two classes, one class appears on the left side of the display and the second class appears on the right side. The message *MERGE THESE CLASSES OR SELECT ANOTHER CLASS* appears at the bottom of the display.

Two classes can be merged by touching the MERGE CLASSES key. After merging, the first beat appears as a template on the left side of the display. The label (M1) follows the class title. Any subsequent beat that fits any of the merged templates is then stored in that class.

You can merge a maximum of two classes into a third class.

**The following constraints apply to merging classes:**

- Two individual templates can be merged into a class with its own existing template.
- One class of two (previously merged) templates can be merged with one additional template.
- If a class has been merged once, then (M1) follows the class number, for example, VE 12 (M1).
- If a class has been merged twice, then (M2) follows the class number, for example, VE 12 (M2).

## Merging Trends

There is no limit to the number of trends that you can merge. Merging trends of arrhythmia data deletes the template for the class that has been merged. If an arrhythmia event occurs that matches the merged class, a new class is created.

## Merge Constraints

**The following additional constraints apply to merging individual classes or trends:**

- Runs and pauses cannot be merged.
- Couplets can only be merged with couplets.
- Single VE classes or trends can be merged with each other or with the dominant, paced, or AV-paced classes/trends.
- If the system cannot merge any of the existing classes or trends, the MERGE key is disabled in menus for those classes or trends.
- Only classes or trends that the system can merge are presented.

# Arrhythmia Trend Graphs

**To display an arrhythmia trend graph:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class for review.
- Select CLASS TREND or GROUP TREND.

**An arrhythmia trend graph consists of:**

- A 1.5-second segment of the selected class waveform on the left (individual class trends only).
- A trend graph of the selected class, or group of classes, on the right. Refer to *Figure 11-2*.

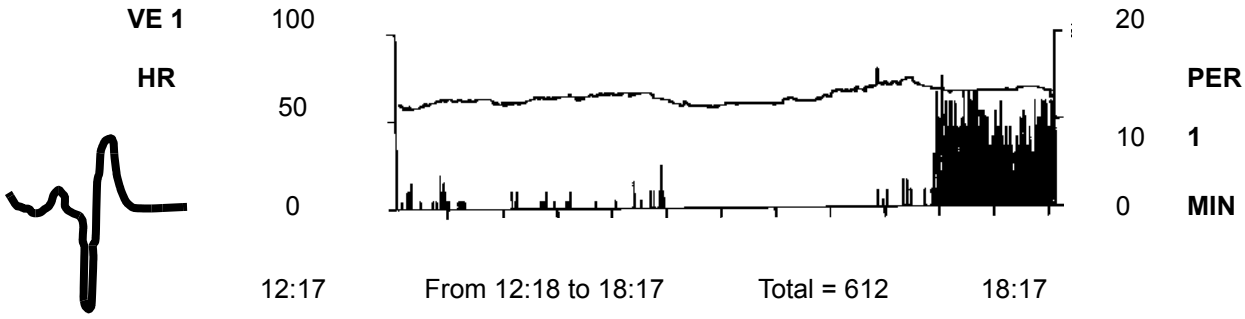



*Figure 11-2: VE class trend*

When you select CLASS TREND, the trend graph shows occurrences of events that match that particular class. The total number of events that occurred during the time period between the cursors appears below the trend graph.

When you select GROUP TREND, the trend graph shows occurrences of all events in that group of classes along with the average heart rate. For example, the group trend for VE classes shows the occurrences of all single, ectopic beats regardless of the class in which they are stored.

- The trend graph for the dominant group displays the total of all ectopic beats, including beats in runs, over the selected timebase.
- A total of all events specific to the selected class over the selected timebase displays for all other trended classes.

Each trend graph is displayed with two scales. These scales are automatically selected based on the heart rate and arrhythmia values.

- The scale on the left represents the heart rate.
- The scale on the right represents the number of arrhythmias detected over the trended period.

## Positioning the Cursors

The cursors are small, bright lines that move along the bottom of the trend display. They enable you to view the number of trended events that occurred between any two time points displayed on the trend graph. Initially, the left (L) cursor is located at the left edge of the trend graph, and the right (R) cursor is located at the right edge of the trend graph. The number of trended events between (and including) the cursor points appears below the trend graph. If the cursors move past each other, the L cursor becomes the R cursor and vice versa.

**To position the cursors on the trend graph:**

- Touch CURSOR L or R to highlight either the left or the right portion.
- Touch the trend graph to position the cursor near the desired point.
- Use the arrow keys for adjustment of the cursor.

**To select a timebase for class or group trends:**

- Display an arrhythmia trend graph.
- Select a TIMEBASE (6, 12, or 24 hours).

## Selecting a Timebase

You can select the time period for the arrhythmia trend graph. The resolution for each timebase is shown below.

| Resolution | Timebase |
|---|---|
| 1 minute = | 6-hour trend graph |
| 2 minutes = | 12-hour trend graph |
| 4 minutes = | 24-hour trend graph |

## Excluding Classes from Trends

You can exclude specific classes from the group trend for that class and from the dominant trend graph (only valid with COUPLET and VE classes). The default setting is INCLUDE / YES, which indicates that all classes will be included. When you select a class, the template for that class appears on the display, followed by a trend graph that shows all of the occurrences of that class over the selected trend graph timebase.

**To exclude a class in a group trend:**

- Display an arrhythmia class trend graph.
- Select INCLUDE / NO.

# Printing Arrhythmia Data

**All printouts are annotated with the following data:**

- Bed identification
- Time and date of the printout
- Lead designator

You can print all arrhythmia data for all classes, or individually selected classes. You can also print individually selected arrhythmia events or trends.

Touch PRINT ALL to print all ST events and all arrhythmia classes. PRINT ALL also prints *all* the leads.

**To print recordings of ALL arrhythmia events:**

- Touch ECG.
- Touch PRINT.
- Touch PRINT ALL.

  -OR-
- Touch ARR CLASSES.

**To print selected arrhythmia classes:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch PRINT.

**To print selected arrhythmia trends:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Select CLASS TREND or GROUP TREND.
- Touch PRINT.

# Arrhythmia Problem Solving

Refer to *ECG Problem Solving* on page 10-25 for additional monitoring tips.

## False Alarms

Careful attention to good monitoring techniques, especially during setup, reduces false alarms.

**When false alarms occur, check for the following:**

- Noise that may be mis-classified as QRS complexes. Review the morphology of VE classes that are triggering alarms. Either merge these VE classes together or deactivate the alarm for these classes.
- V FIB that may resemble previously classified ectopic beats. This may cause V FIB to be detected as a VRUN. If this occurs, use the waveform display as the primary indication of condition.
- Some beats may not be recognized as being morphologically different from the learned dominant beat. You may be able to improve performance by changing electrode positions or switching to a lead setting that provides better differentiation between the dominant and ectopic beats.

## Ectopic Beats Improperly Classified

**Several conditions may cause beats to be improperly classified:**

- The message *NOISY SIGNAL* indicates too much noise is present on one or both ECG channels.
- The message *ECG VOLTAGE TOO LOW* indicates that the signal level is below the threshold for QRS detection.
- Some beats are not recognized as being different from the learned dominant beat.

You may be able to improve performance in these cases by changing electrode positions or by switching to a lead setting that provides a better signal or allows ectopic beats to be more clearly differentiated from dominant beats.

## No Ventricular Couplet or Ventricular Run Alarms

**If alarms do not occur as expected, check the following:**

- Ectopic beats may not meet the classification criteria for ventricular rate and consecutive beats. Check the rate and length limits and adjust as necessary. A Ventricular Run alarm will not be generated unless both criteria are met.
- Processing may have been suspended or the signal quality may be poor. Resume processing or check electrodes for other causes of a poor signal.

## Previous VE Classes Missing in Arrhythmia Review

**If you find that previously classified ectopic beats are no longer stored for review, one of the following conditions has occurred:**

- The class has been cleared.
- The memory (data) was cleared (purged) using the RELEARN key, or during the Admit/Discharge function.
- A module error recovery reset occurred.

## Classes Full

The total number of VE and couplet classes that can be stored is 12. When the system detects the 13th class, the message *CLASSES FULL* appears with an alert tone (if the tone is set to ON).

**A Classes Full condition can be cleared by:**

- Merging one or more classes.
- Merging one or more trends.
- Deleting one or more classes for VEs or couplets.

***Note:***

*All alarm events occurring when classes are full will initiate an appropriate alarm.*

# Arrhythmia Troubleshooting Guide

**Caution:**

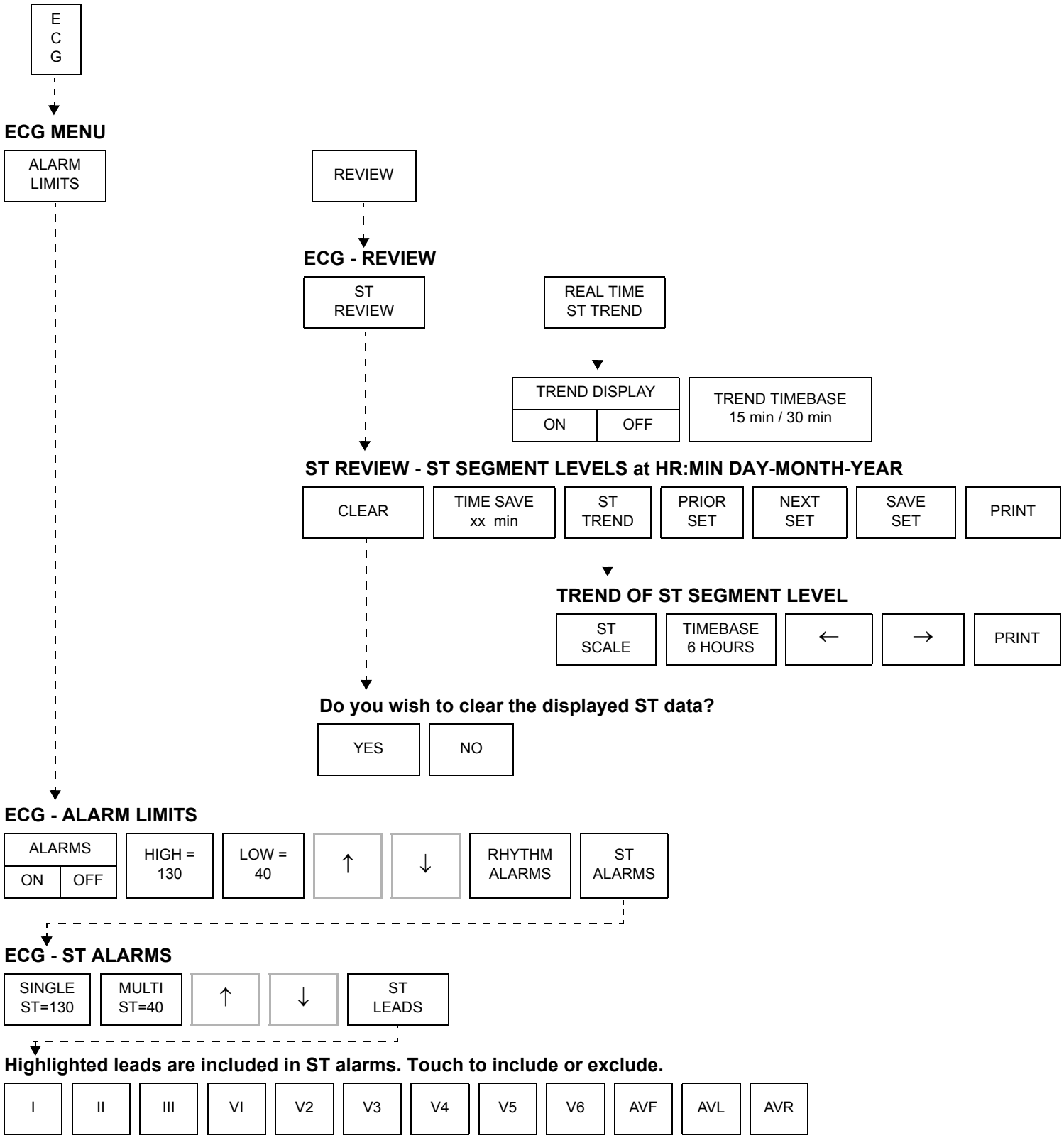
**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Ectopic beat not detected** | ■ Inadequate signal; *NOISY SIGNAL* or *ECG VOLTAGE TOO LOW* messages appear. Noise level is above allowable range, or signal level is below QRS detection threshold. | ■ Make the necessary adjustments to restore a good signal. |
| | | ■ Check all leads to determine a better monitoring lead, or select another lead. |
| | | ■ Remove the cause of the noise. |
| | ■ Some beats not recognized as morphologically different from the learned dominant beat. | ■ No action required. Some events that may be diagnosed as abnormal by a skilled clinician may not meet the module's criteria for abnormality. |
| | ■ System has not detected five ectopic beats or three couplets of similar morphology needed to qualify a class. | ■ No action is required. |
| | ■ Arrhythmia detection is not enabled. | ■ Enable arrhythmia detection through the **ECG Setup** menu. |
| **False Alarms** | **Note:** Careful attention to good monitoring technique, especially setup, keeps false alarms at a low level. If false alarms do occur, check the following. | |
| | ■ Noise on the signal caused by poor electrode application is the most common cause of false alarms. | ■ Remove the cause of the noise. |
| | | ■ Deactivate alarm for classes that fill up with repetitive artifact. Do not clear these classes. |

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **False Alarms (continued)** | ■ Limits set too close to patient's heart rate. | ■ Check and adjust the alarm limits. |
| | ■ Amplitude of ECG signal has dropped below threshold of R-wave detector. | ■ Reposition electrodes and relearn patient's rhythm. |

# ST Analysis

## Directory of Keys



# ST Analysis

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## Overview

The ST analysis function monitors changes to the ST segment level. Only a clinician can determine the significance of ST changes.

**The accuracy of ST segment measurements may be affected by:**

- Wide complex QRSs (for example, bundle branch block)
- Wolff-Parkinson-White (WPW) syndrome
- Fusion beats classified as dominants

The ST segment is composed of frequencies at the lower end of the frequency range (0.05 Hz). The system automatically analyzes the ST segment at 0.05 Hz whether the display mode is set to MONITOR or EXTENDED.

ST segment analysis starts during the ECG learn sequence. Based on the dominant waveform, the PR (isoelectric), J, and ST points are automatically identified for each beat. The amplitude difference between the ST point and the PR point is referred to as the ST segment level.

# Display Detail

The current ST segment level is displayed for all leads to the right of the ECG parameter key in both the SPLIT-VIEW and FULL-VIEW modes. Question marks (**???**) appear when the current ST segment level is not available. OFF appears when the lead is not connected.

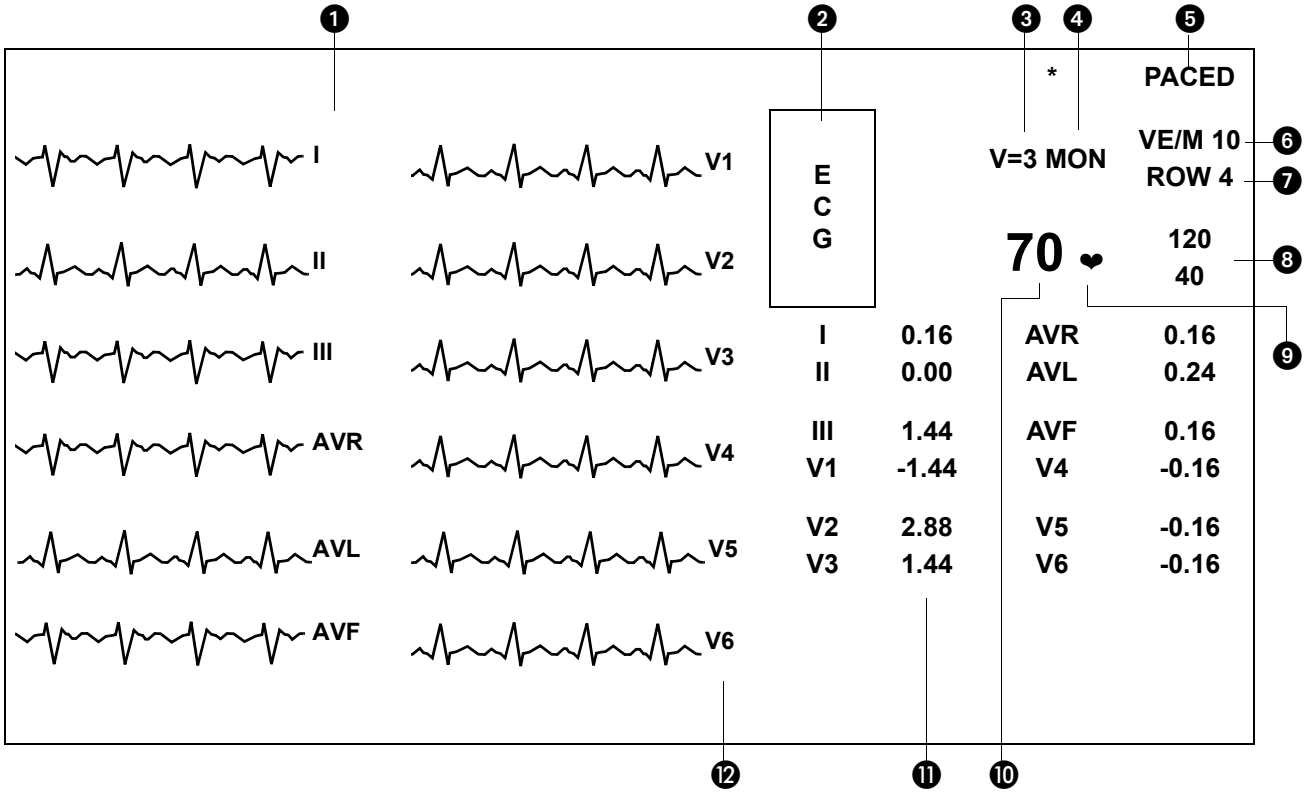



*Figure 12-1: Full-view display, bedside monitor*

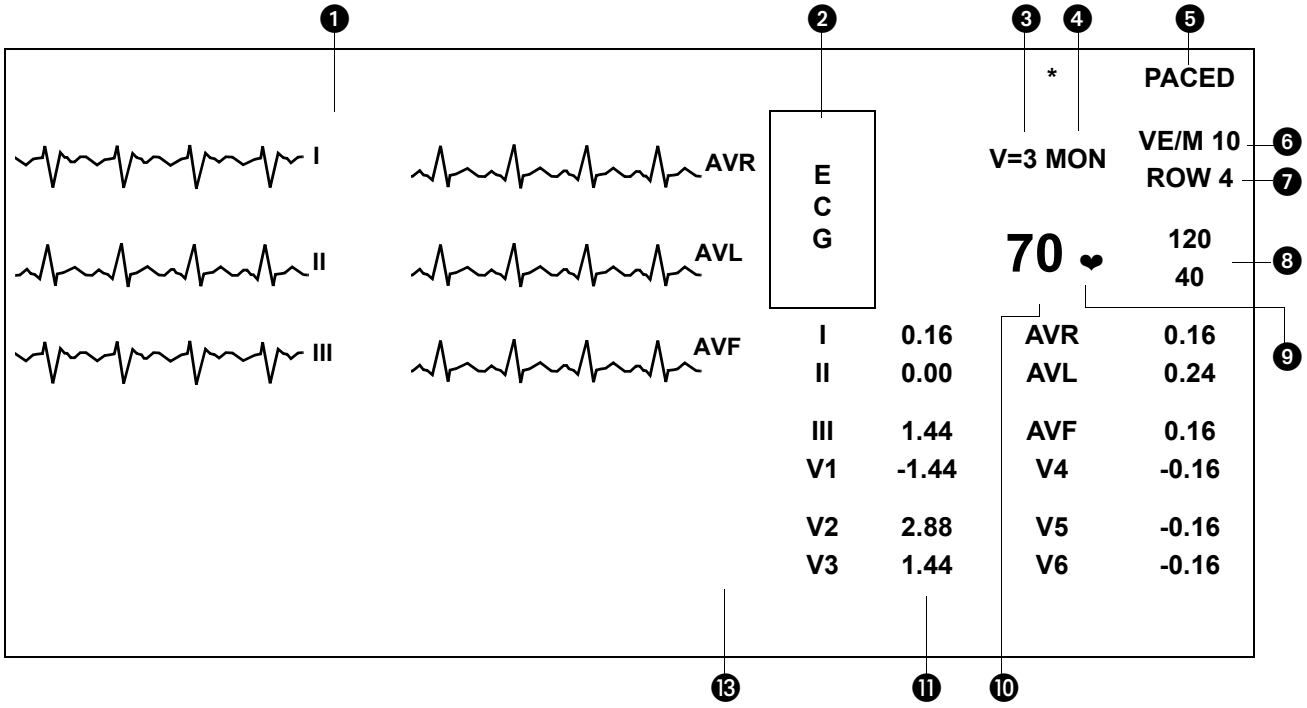



*Figure 12-2: Split-view display, bedside monitor*

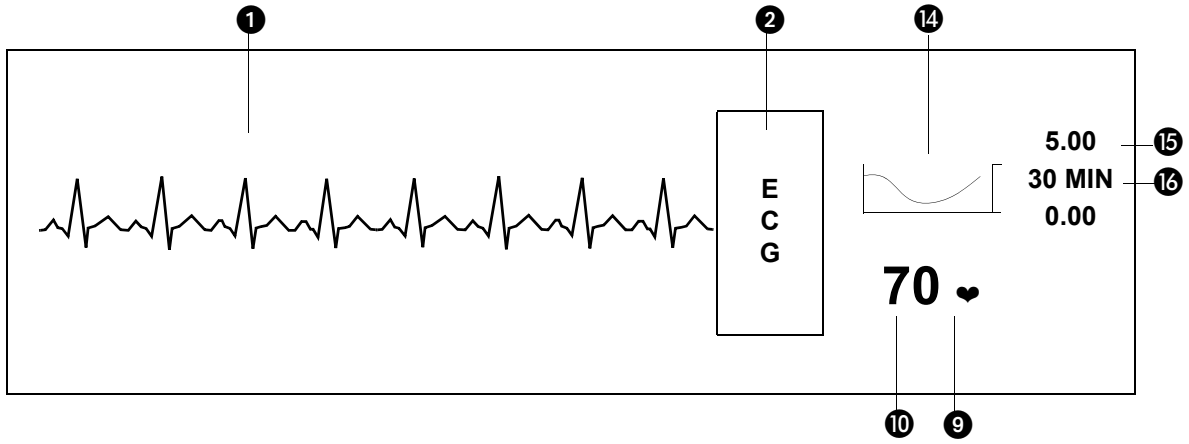



*Figure 12-3: Real-time ST trend display*

1. ECG waveform for first lead
2. ECG parameter key
3. VEs-per-minute counter *
4. Display resolution (MONITOR or EXTENDED)
5. PACED mode indication (pacemaker detection is enabled)
6. VEs-per-minute alarm limit *

❼ Ventricular run alarm limit *

❽ ECG rate alarm limits (split-view central monitors display a bell symbol when alarms are enabled)

❾ QRS indicator (flashes once per detected beat)

❿ Current heart rate

⓫ ST Segment levels for full-view and split-view display

⓬ ECG full-view display

⓭ ECG split-view display

⓮ Real-time ST trend

⓯ Amplitude scale in millivolts

⓰ Time scale — either 15 or 30 minutes

* *Only appears with the Multiview I or II option in the ADULT mode with Arrhythmia detection enabled.*

# Setting Up ST Monitoring

ST analysis is performed on all available ECG leads, even if they are not currently displayed. Setup for ST monitoring is the same as for ECG monitoring (refer to *ECG Setup* on page 10-6).

***Note:***

*ADULT mode ST analysis and review functions are only available in modules with the ST option.*

**To set up ST monitoring:**

- Set up system and patient for standard ECG monitoring.
- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ADULT.

# Enabling and Adjusting Alarms

ST alarms can be activated manually or automatically, typically within 30 to 60 seconds after completion of the learn sequence. You can adjust alarm limits in increments of 0.25 mm, as needed, for both single-lead ST and multiple-lead ST alarm conditions. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To enable and adjust ST alarms:**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch ST ALARMS.
- Select SINGLE ST or MULTI ST.
- Use the arrow keys to adjust.

The SINGLE ST alarm enables you to monitor localized changes that may only be detectable in a single lead. An ST alarm for a SINGLE LEAD activates if the ST level for *any* one lead exceeds the SINGLE ST alarm limit, with respect to its current reference level.

The MULTI ST alarm enables you to monitor global changes that may be detectable in multiple leads. An ST alarm for MULTIPLE LEADS activates if the ST level for three or more leads exceeds the MULTI ST alarm limit, with respect to each lead's current reference level.

***Note:***

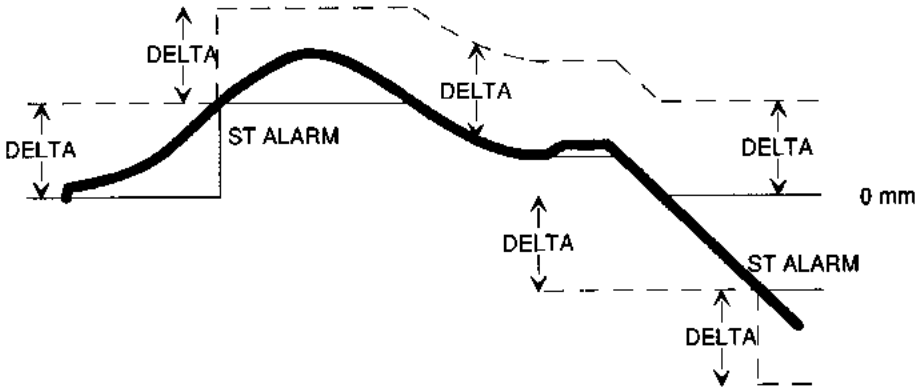
- *Disabling ECG alarms also disables ST alarms.*
- *The MULTI ST alarm limit cannot be set equal to or above the SINGLE ST alarm limit if both alarms are enabled.*

When ST monitoring is initiated, the reference level for all leads is set to 0.00 mm (isoelectric).

- A SINGLE ST alarm activates if any lead has an initial ST level that exceeds the SINGLE ST alarm limit.
- A MULTI ST alarm activates if three or more leads have initial ST levels that exceed the MULTI ST alarm limit.

When a SINGLE or MULTI ST alarm is activated, the reference level for all leads is automatically reset based on each lead's current ST level. This enables you to track changes in ST levels throughout the patient's course of treatment.

In *Figure 12-4*, DELTA denotes the amount of change needed to set off another alarm. The figure shows that when the patient's ST segment trend line rises and violates the first alarm threshold, a new baseline and a new upper alarm threshold are established (the lower alarm threshold remains unchanged). The patient's ST level continues to climb. However, it does not reach the new alarm threshold, so a new baseline and upper limit are not set. When the ST level declines, the alarm threshold also declines until the original alarm thresholds are re-established. As the patient's ST level continues to decline, a new lower alarm threshold is established when an alarm condition occurs.




Thick line = measured ST level

Solid line = ST alarm baseline

Dashed line = alarm threshold

*Figure 12-4: ST segment alarm function*

As a second example, assume the SINGLE ST alarm is set at 1.00 mm.

- The initial ST amplitude for a particular lead is +0.60 mm.
- Based on the initial reference level of 0.00 mm, an alarm will activate if the ST level exceeds +1.00 mm. Therefore, no alarm occurs.
- The ST level increases immediately to +1.20 mm.
- A SINGLE ST alarm occurs and the new reference level for the lead is set to +1.20 mm.
- The next ST alarm for that lead, assuming no changes are made in other leads, will activate at +2.20 mm.

# Selecting Leads for ST Alarms

Touch the ST LEADS key to select which leads are to be used to generate ST alarms. You can disable leads that are not clinically relevant for a patient to allow tighter limits to be placed on more clinically significant leads. All highlighted leads are used to generate ST alarms.

**To select or deselect leads for ST alarms:**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch ST ALARMS.
- Touch ST LEADS.
- Select or deselect leads.

# Reviewing ST Data

Use the **ST Review** menu to display and review ST segment data. A snapshot of ST segments for all available leads displays. The time and date of the snapshot is displayed on the menu prompt line. Touch the PRIOR SET or NEXT SET key to display ST data at other time points. *Figure 12-5* shows an example of an ST segment snapshot.

**To review ST data:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.

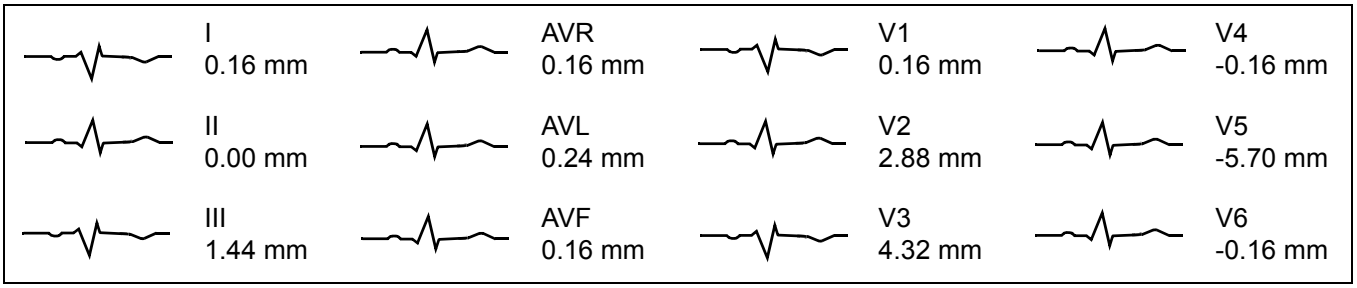



*Figure 12-5: ST segment display*

You can store up to nine snapshots. The oldest snapshot not marked as SAVED is deleted to make room to store a new snapshot. To save a snapshot, touch the SAVE SET key.

Snapshots are automatically stored when an ST alarm occurs or at pre-selected time intervals. To store the snapshots at periodic intervals, select TIME SAVE / YES. You can set the interval in the Module Configuration Manager.

# Clearing ST Data

Touch the CLEAR key and then confirm your choice by selecting YES to clear the currently displayed data for all leads from memory. Data is also cleared from the trends.

**To clear the displayed ST data:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch CLEAR.
- Select YES.

# Viewing ST Trends

Trends showing deviations in ST segment level are displayed for each lead monitored in the previous 24 hours (refer to *Figure 12-6*). Touching the trend graph or one of the arrow keys in the menu displays a cursor on the baseline of the trend graph. Position this cursor at a point of interest in the trend to determine the ST segment level for all displayed leads at that time. A measurement for each lead displays in the table to the right of the trend graph.

**To view ST trends:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch ST TREND.
- Touch the trend graph near the desired data point. Then use the arrow keys to adjust the cursor position.

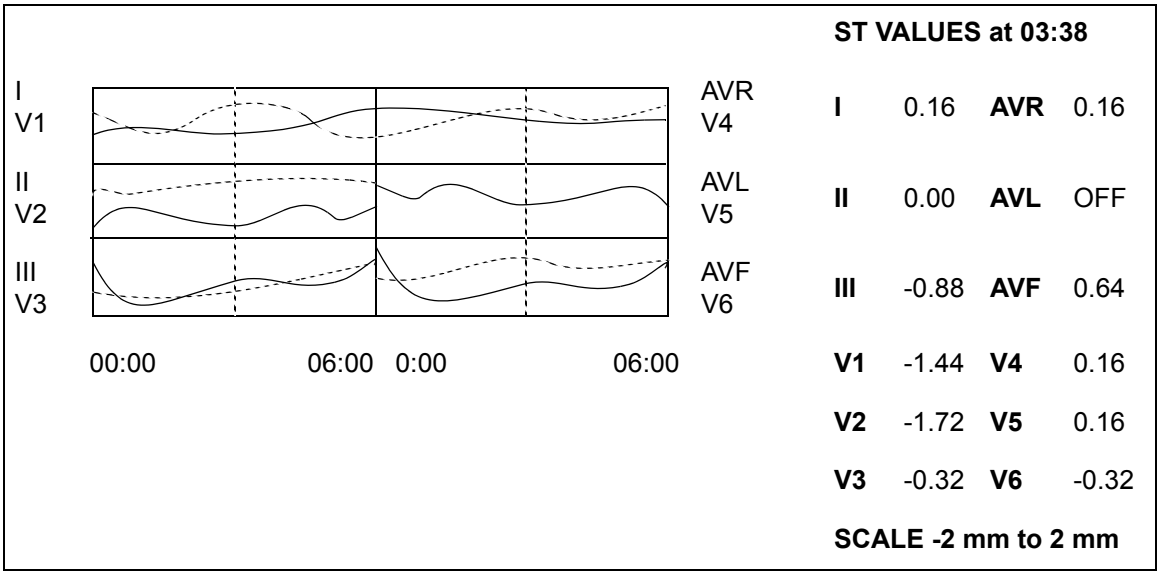



*Figure 12-6: ST trend display*

## Selecting the ST Trend Timebase

You can set the timebase for the ST trend graphs to 1.5, 3, 6, 12, or 24 hours. The displayed resolution for each timebase is as follows.

| Resolution | Timebase |
|---|---|
| 30 seconds | 1.5 hours |
| 1 minute | 3 hours |
| 2 minutes | 6 hours (default) |
| 4 minutes | 12 hours |
| 8 minutes | 24 hours |

**To select a timebase:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch ST TREND.
- Select TIMEBASE of 1.5, 3, 6, 12, or 24 hours.

# Printing ST Data

**Printouts of ST segment data are annotated with the following:**

- Bed identification
- Time and date of the printout
- Lead designator

**You can print ST segment waveforms from either the Print or ST Review menu:**

- To print *all* the available ST segment waveforms, use the **ECG Print** menu.
- To print only *selected* ST segment waveforms or ST trends, use the **ST Review** menu.

***Note:***

*ST segment data cannot be printed using the 90449 printer module.*

**To print all ST segment data:**

- Touch ECG.
- Touch PRINT.
- Touch ST SEGMENTS.

**To print selected ST segments:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch PRINT.

**To print the current trend data:**

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch ST TREND.
- Touch PRINT.

# Displaying Real-Time ST Trends

To facilitate the assessment of short-term changes in ST-segment levels, measurements for a single lead can be displayed as a real-time trend (refer to *Figure 12-3*). Trend data is continuously updated at three-second intervals. You can select either a 15- or 30-minute time scale for the trend display. The amplitude scale for the trend display adjusts to show the maximum and minimum values for the selected time scale.

**To display a real-time ST trend:**

- Touch ECG.
- Touch REVIEW.
- Touch REAL TIME ST TREND.
- Select ON.
- Touch TREND TIMEBASE to select 15 or 30 minutes.

# ST Analysis Troubleshooting Guide

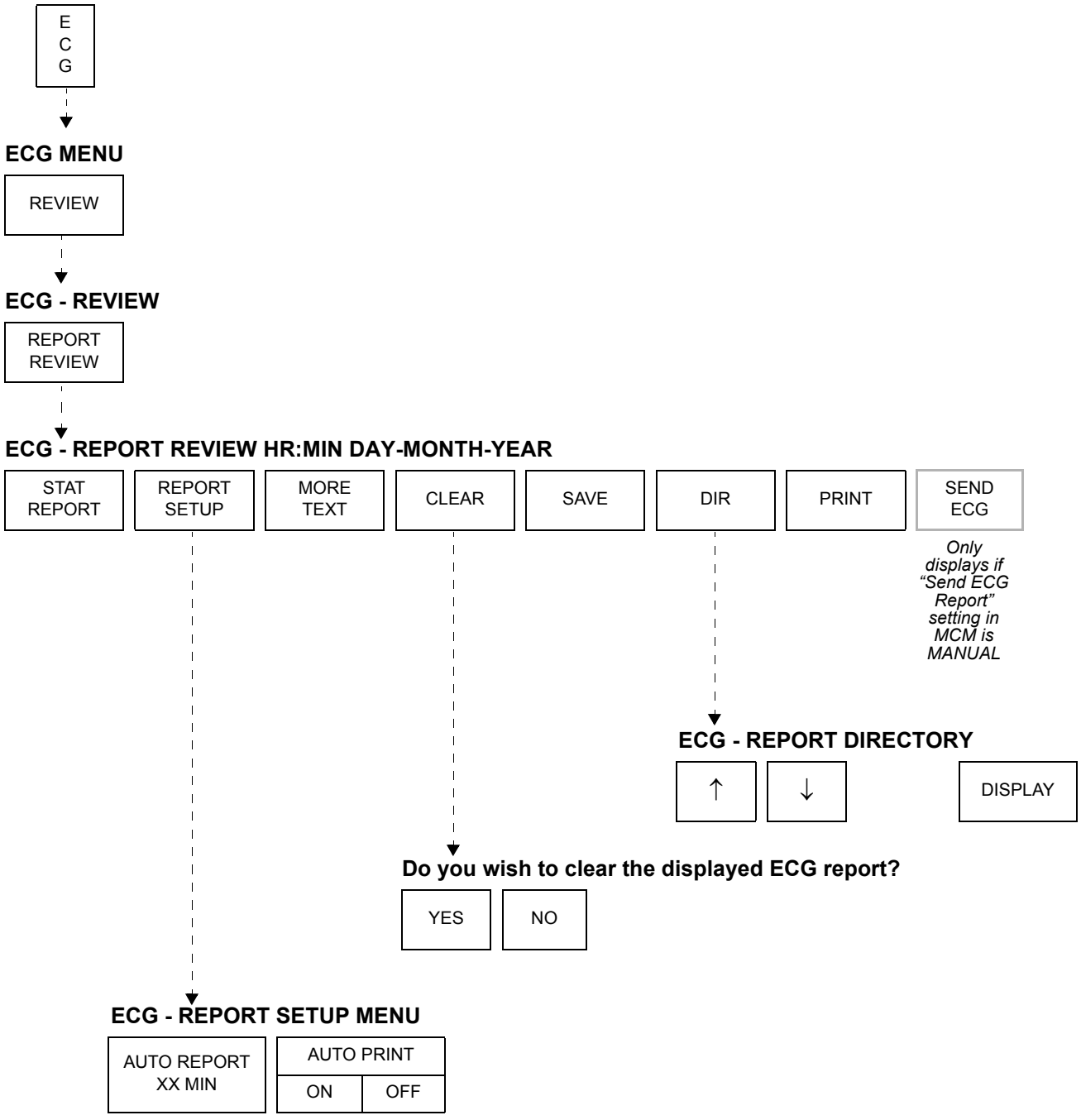
**Caution:**

**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No access to ST analysis functions** | ■ The system must learn the ST segment level before it can provide access to ST analysis functions. | ■ Wait until the system analyzes sufficient QRS complexes to calculate the ST segment level (approximately one minute). |
| **ST = ?? appears** | ■ Infrequent occurrence of dominant beats. | ■ ST analysis is not performed on paced, premature dominant, or abnormal beats. |
| | ■ ECG amplitude may be insufficient to detect QRS complexes. | ■ Check QRS amplitude. |

# 12-Lead Diagnostics

## Directory of Keys



# 12-Lead Diagnostics

## Contents

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Sending 12-Lead ECG Reports . . . . . 6
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## Overview

Diagnostic electrocardiographic devices obtain conventional ECG signatures that accurately represent both the detailed waveforms in each cardiac cycle and the beat-to-beat variability to determine cardiac rhythm.

The 12-lead report function acquires and displays 12 ECG vectors in the same format as an electrocardiograph.

Prior to analysis, the ECG data are split into two different paths: one to the system's monitoring functions and the other to its diagnostic functions. The data in the diagnostic path are acquired at a rate of 500 samples per second, as required by U.S. and international standards for diagnostic electrocardiographic devices.

***Note:***

- *No automated analysis is completely reliable. A physician should review all ECG results.*
- *Special problems exist with pediatric ECGs because of the considerable differences in the signal characteristics of adults and infants and because of the evolution of the ECG patterns from birth to adolescence.*
- *Digital systems produce a noticeable modulating effect from one cycle to the next, particularly in pediatric ECGs. This is due to the asynchronism between the sample rate for data acquisition and the peak of the QRS waveform.*

# Display Detail

The 12-lead report displays 2.5 seconds of waveform data per lead. The leads can be presented in standard format (refer to *Figure 13-1*) or in Cabrera format. When the analysis is complete, measurements and diagnostic statements may appear above the waveform data.

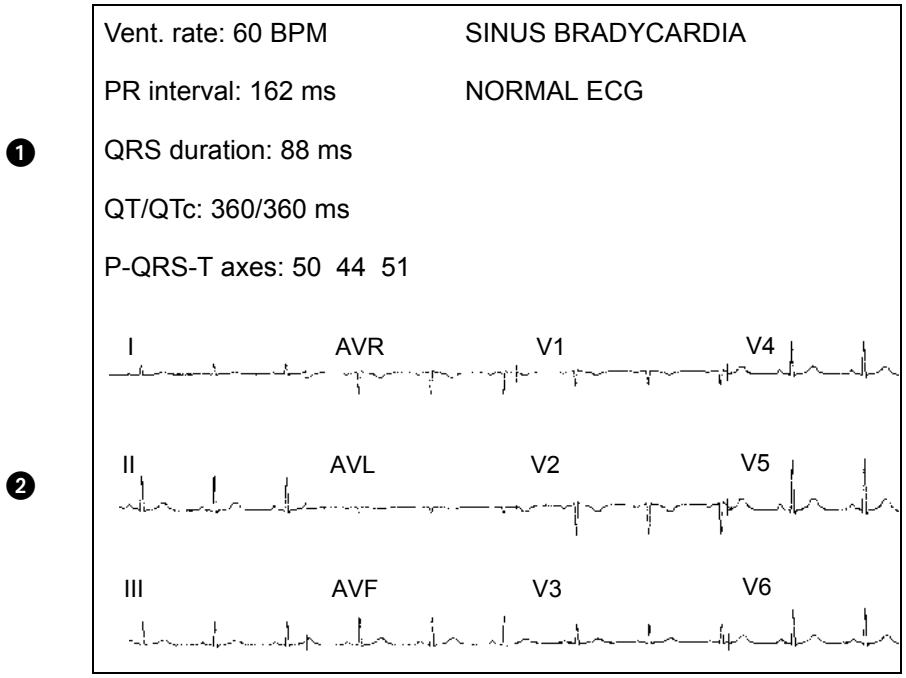



*Figure 13-1: 12-lead report display*

1. Measurement and interpretation data (requires the Diagnostic Interpretation feature — Option D)
2. ECG waveforms for 12 leads (2.5 seconds/lead)

# Acquiring and Printing 12-Lead Reports

***Note:***

*ECG processing and the pacemaker detection function are suspended for 10 seconds during acquisition of a 12-lead ECG report. This enables the actual pacemaker pulse to appear in the 12-lead report without interfering with arrhythmia analysis.*

Twelve-lead reports can be acquired manually (a stat report) or automatically on a scheduled basis. (Initiating a stat report does not affect acquisition of previously scheduled reports.) Any displayed report can be printed by touching the PRINT key.

Because 12-lead reports cannot be acquired if any lead is disconnected, check all electrode connections regularly after the patient is connected to the system. If a lead is disconnected, scheduled reports are skipped and the STAT REPORT key is disabled.

Scheduled reports are automatically acquired at the time interval selected using the AUTO REPORT key. They are not acquired if OFF is selected. Scheduled reports can automatically print when they are acquired (set AUTO PRINT to ON), or they can be saved on the hard disk for later review and printing (set AUTO PRINT to OFF).

If you are using a PrintMaster or an ICS printer, and if all the leads are connected, touching the STAT REPORT key provides a 12-lead report. For this recording format, 2.5 seconds of waveform data are printed for each lead, plus 10 seconds of waveform data for a rhythm lead.

You can schedule a 12-lead report to print at regular time intervals using the AUTO REPORT and AUTO PRINT features. Available intervals are 30 minutes, 1, 2, 4, 8, and 24 hours.

***Note:***

- *A 12-lead report can only be printed using the PrintMaster or an ICS printer.*
- *A PrintMaster (with software version 1.10.04 or greater) is required for the STAT REPORT feature.*

**To acquire and print a 12-lead ECG report:**

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.

**Manual acquisition:**

- Touch STAT REPORT.
- Touch PRINT.

**Automatic acquisition at pre-selected intervals:**

- Touch REPORT SETUP.
- Select AUTO REPORT of 30 minutes, 1 hour, 2 hours, 4 hours, 8 hours, or 24 hours.
- Touch AUTO PRINT / ON.

# Saving and Clearing 12-Lead Reports

Several 12-lead reports can be stored in the system's hard disk. (The exact number depends on the ECG waveforms' signal quality, the frequency, and the complexity of the arrhythmias.) When the disk space is full, the oldest report that is not saved is replaced by the newest report.

You can save a report indefinitely by touching the SAVE key while the report is displayed. You can delete a report from the hard disk by touching the CLEAR key (then confirm your choice by touching YES) while the report is displayed.

**To save or clear a 12-lead ECG report:**

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Select the desired report.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.
- Touch SAVE to save the report.

  -OR-
- Touch CLEAR and then touch YES to confirm.

***Note:***

*Clear the 12-lead report(s) from memory before proceeding to the next patient's bedside monitor if:*

- *Your monitoring system is interfaced to an ECG Management System, and*
- *You are using a single module to acquire 12-lead reports at multiple bedside monitors.*

# Sending 12-Lead ECG Reports

An ECG management system can acquire 12-lead ECG reports from the monitoring system either automatically (as they are acquired) or manually (when you send them). This depends on how your module is configured using the Module Configuration Manager feature.

- If the Send ECG Report feature is set to Automatic, all reports are automatically sent to the ECG management system and the SEND ECG key is not displayed.
- If the Send ECG Report feature is set to Manual, the SEND ECG key is displayed. Touch SEND ECG to send the displayed report to the ECG management system.

**To manually send 12-lead ECG reports:**

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.
- Touch SEND ECG.

# Viewing the Report Directory

Touch the DIR key to display a directory of 12-lead reports. Each report's time and date and its summary diagnosis (if the Diagnostic Interpretation feature is enabled) appear as a table. Saved reports are marked as YES in the SAVED column (refer to *Figure 13-2*). Use the arrow keys to select the desired report, and then touch the DISPLAY key to display the selected diagnostic report.

**To view directory of 12-lead ECG reports:**

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.

| TIME | DATE | SAVED | DIAGNOSIS |
|---|---|---|---|
| 1:00 | 28 MAR | YES | ABNORMAL ECG |
| 1:30 | 28 MAR | | NORMAL ECG |
| 2:00 | 28 MAR | | NORMAL ECG |
| 2:30 | 28 MAR | | NORMAL ECG |
| 3:00 | 28 MAR | YES | ABNORMAL ECG |
| 3:30 | 28 MAR | YES | NORMAL ECG |

*Figure 13-2: Report directory*

# Entering Patient Demographics

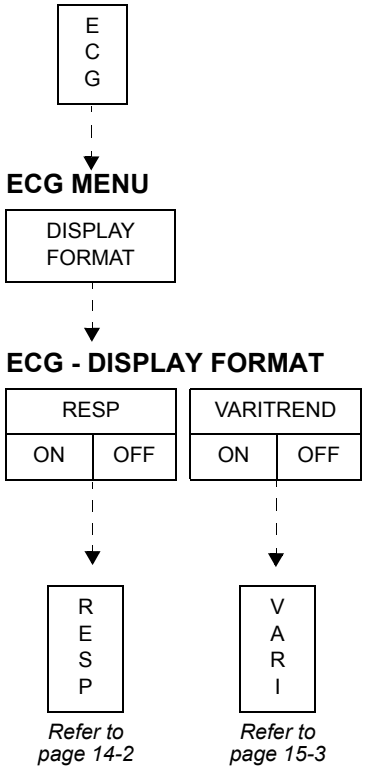
The diagnostic ECG algorithm requires the patient's gender, date of birth, height, and weight. You must enter the patient's demographics correctly to obtain an accurate diagnosis. This information is entered through the Admit function (refer to *Admit/Discharge* on page 8-3). If patient demographic information is not entered, the diagnostic ECG algorithm uses the following defaults:

| **Demographic** | **Default Value** |
|---|---|
| Date of Birth | 40 years |
| Gender | Male |
| Height | 5 feet 10 inches |
| Weight | 180 pounds |

# Respiration

## Directory of Keys

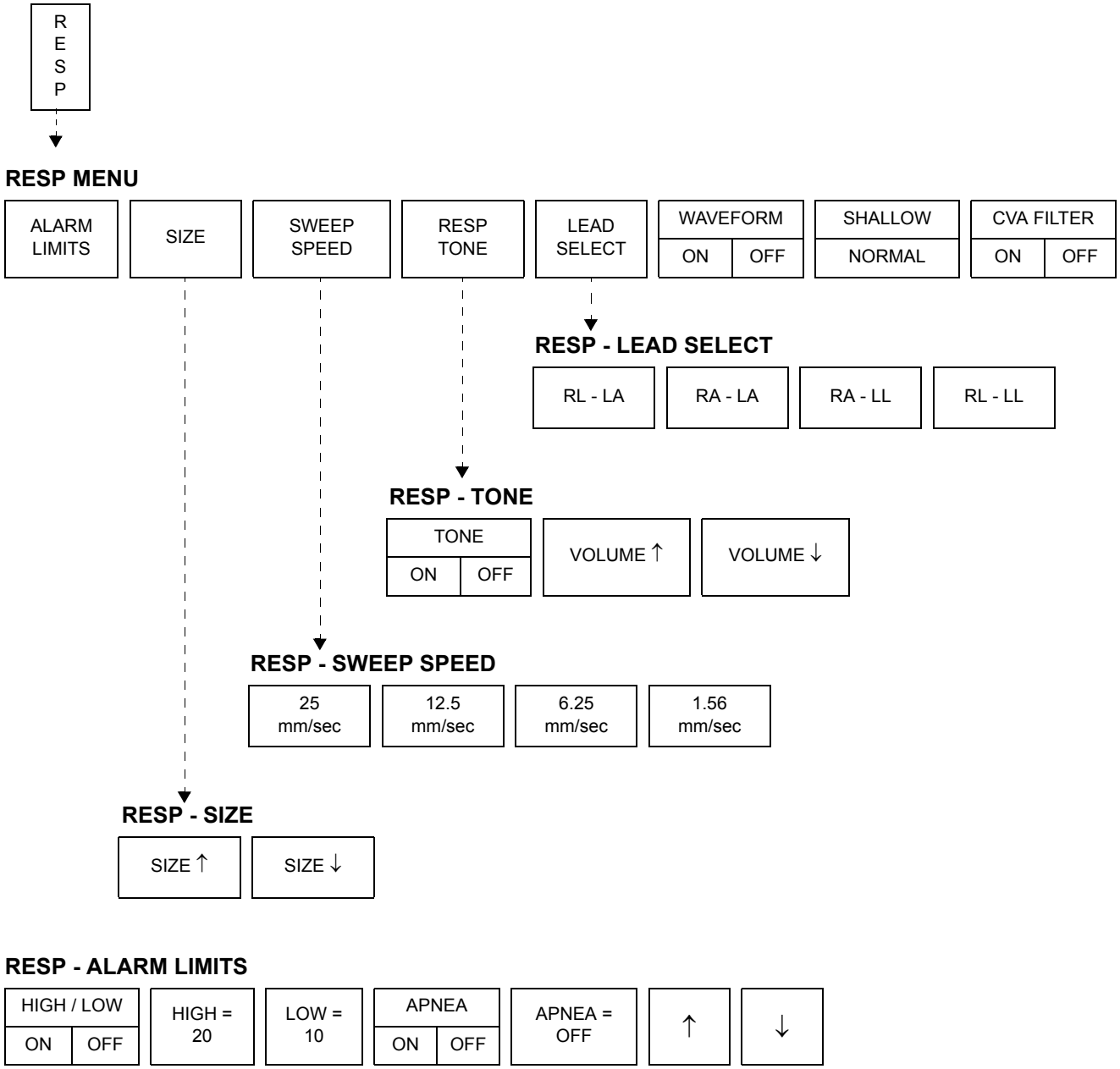
### ECG




*Refer to page 14-2*

*Refer to page 15-3*

# Respiration




**RESP - ALARM LIMITS**

# Respiration

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Overview . . . 3
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## Overview

Changes in thoracic impedance during patient inspiration and expiration provide respiration data through the ECG cable. Lead selection for respiration is independent from the lead selection for ECG, even though both receive data from the same electrodes.

**The Respiration function:**

- Displays a waveform representing each breath.
- Provides the respiration rate.
- Detects and rejects cardiovascular artifact.
- Initiates alarms when limits are violated for either the respiration rate or apnea.

***Warning:***

- ***Do not use this device to detect obstructive or mixed apneas. This device's respiration function detects central apnea, but does not recognize obstructive and mixed apneas.***
- ***The respiration function's apnea alarm occurs when a preset time has elapsed since the last detected breath. The safety and effectiveness of the respiration function for the detection of apnea has not been established, particularly for the apnea of prematurity and the apnea of infancy.***

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to respiration monitoring. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

***Warning:***

***Some rate adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.***

# Setting Up Respiration Monitoring

The RESP key must be set to ON in the **ECG Display Format** menu to display the RESP parameter key.

***Note:***

*To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

**Caution:**

**If you suspend ECG processing using the SUSPEND PROCESSING key in the ECG menu, you also suspend respiration processing.**

**To set up respiration monitoring:**

- Attach the patient ECG leads (as described in *Patient Preparation and Electrode Application* on page 10-7).
- Plug the ECG cable into the module's ECG input.
- Touch ECG.
- Touch DISPLAY FORMAT.
- Select RESP / ON.
- Touch RESP.
- Select additional keys as necessary.

# Display Detail

*Figure 14-1* shows the appearance of the Respiration parameter on the monitor display.

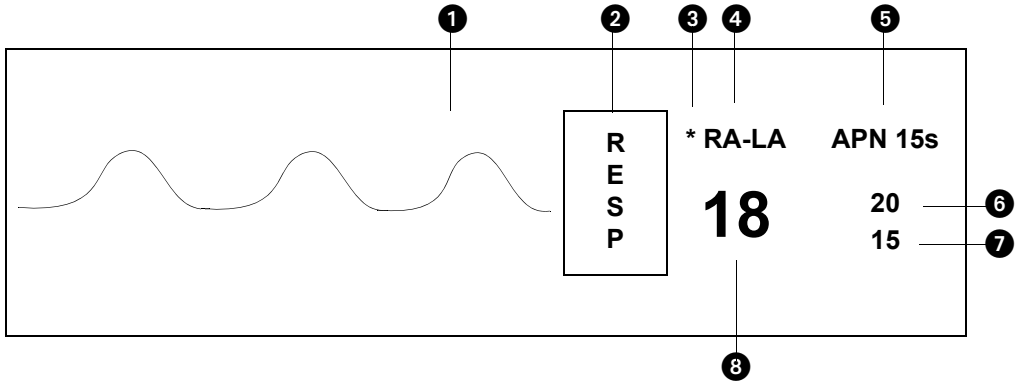



*Figure 14-1: Bedside monitor*

1. Respiration waveform
2. RESP parameter key
3. Respiration indicator (flashes once per detected breath)
4. Selected lead for respiration
5. Apnea alarm limit in seconds
6. High respiratory rate alarm limit
7. Low respiratory rate alarm limit
8. Current respiratory rate

# Selecting ADULT or INFANT Mode

The respiration function provides both adult and infant operational modes to optimize monitoring accuracy. When you select ADULT or INFANT, respiration alarm limits and breath detection sensitivity are adjusted based upon your selection.

**Caution:**

**When INFANT is selected, alarm activation for ECG and respiration can be delayed for up to three minutes. Closely observe the patient during this period.**

**To specify the patient type:**

- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ADULT or INFANT.

# Adjusting Respiration Sensitivity

You can select shallow or normal input sensitivities for respiration monitoring based on the patient's respiratory effort. Use the SHALLOW mode if the monitor has difficulty counting the respiratory rate or the waveform is difficult to read. Selecting SHALLOW also lowers the detection sensitivity nearer to the low amplitude waveform of infants.

**To adjust respiration monitoring sensitivity:**

- Touch RESP.
- Select SHALLOW or NORMAL.

# Using the Cardiovascular Artifact Filter

Respiration is monitored based on impedance changes that occur with the expansion and contraction of the chest. However, the physical action of the heart pumping blood and the flow of blood through the vasculature also create changes in impedance known as cardiovascular artifact (CVA). In the absence of respiration (for example, during episodes of apnea), the waveform in the respiration zone may represent CVAs rather than true respirations. In such cases, the respiratory rate is the same as the heart rate.

The CVA detection filter provides a method of discriminating between true respiratory effort and cardiac activity. The filter checks for coincidence between the respiratory rate and the heart rate.

**If the rates are the same:**

- The digital display for respiratory rate changes to CVA.
- A CVA message appears in the waveform zone.
- An apnea alarm is triggered (if it is enabled).

This minimizes the possibility of apneic episodes going undetected because of CVA. Episodes of CVA are reflected with a respiratory rate of zero in the trends.

If the patient's respiratory and heart rates are identical, you may want to disable the CVA filter to avoid an apnea alarm.

***Warning:***

***If you disable the CVA detection filter, you will not be alerted to the presence of CVA if it replaces the respiration waveform.***

**To enable/disable the CVA filter:**

- Touch RESP.
- Select CVA FILTER / ON or OFF.

# Selecting Respiration Leads

Respiration lead selections (using the AAMI electrode identifier from *Table 1*) are RL-LA, RA-LA, RA-LL, and RL-LL.

- RA-LA represents the line of maximum respiratory effort in adults and chest-breathing infants.
- RA-LL represents the line of maximum respiratory effort in abdominal-breathing infants.

*Table 1: Electrode Color and Identifier Codes*

| AAMI Electrode Identifier | AAMI Color Code | Electrode Placement | IEC Electrode Identifier | IEC Color Code |
|---|---|---|---|---|
| RA | White | Right Arm | R | Red |
| LA | Black | Left Arm | L | Yellow |
| LL | Red | Left Leg | F | Green |
| RL | Green | Right Leg | N | Black |

**To select respiration leads:**

- Touch RESP.
- Touch LEAD SELECT.
- Select the appropriate lead configuration.

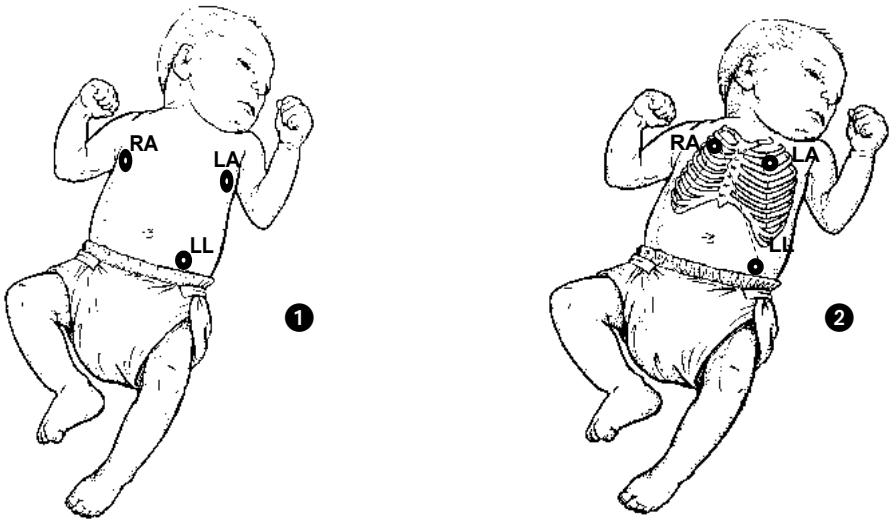



*Figure 14-2: Infant electrode placement*

❶ Maximum Impedance Change

Position RA and LA electrodes at the nipple level, anterior axillary line. Position LL below the diaphragm and preferably below the umbilicus.

❷ Alternate Method

Position RA and LA electrodes at the 2nd intercostal space, midclavicular line. Position LL below the diaphragm, preferably below the umbilicus.

# Enabling and Adjusting Alarms

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To enable and adjust respiration rate alarms:**

- Touch RESP.
- Touch ALARM LIMITS.
- Select HIGH/LOW / ON.
- Select HIGH = or LOW =.
- Use the arrow keys to adjust.

**To enable and adjust apnea alarms:**

- Touch RESP.
- Touch ALARM LIMITS.
- Select APNEA / ON.
- Touch APNEA =.
- Use the arrow keys to adjust.

***Note:***

*If the alarm limit for high rate or low rate appears as reverse video, the Alarm Tone, Alarm Recording, and Alarm Watch features are disabled.*

The apnea alarm limit is the maximum duration allowed between breaths before the respiration rate is set to zero. The apnea alarm limit can be set from 5 to 40 seconds in 5-second increments.

- If APNEA is turned ON, the apnea alarm will sound when the apnea limit is reached.
- If APNEA is turned OFF, the respiration rate will be set to zero after 20 seconds or when the apnea alarm limit is reached, whichever is greater. If the low rate alarm is ON, it will sound 10 seconds after the rate is set to zero.

# Selecting Other Settings

You can turn the waveform OFF and display only the numeric values. When the waveform is OFF, the SWEEP SPEED key and the SIZE keys are disabled.

If the waveform is too large to fit within the display zone, use the waveform SIZE keys to adjust the display size. This does not affect the signal gain or breath detection sensitivity.

The sweep speed determines the speed at which the respiration waveform moves across the display.

You can select an audible tone to sound with each respiratory cycle. The tone volume is adjustable or can be disabled.

**To turn the waveform display ON or OFF:**

- Touch RESP.
- Select WAVEFORM / ON or OFF.

**To adjust the waveform size:**

- Touch RESP.
- Touch SIZE.
- Adjust the waveform size using SIZE ↑ or SIZE ↓.

**To select a waveform sweep speed:**

- Touch RESP.
- Touch SWEEP SPEED.
- Select the desired speed.

**To adjust the respiration tone volume:**

- Touch RESP.
- Touch RESP TONE.
- Select TONE ON.
- Adjust the tone volume using VOLUME↑ or VOLUME↓.

# Printing Respiration Waveforms

You can print respiration waveforms and values. Refer to *Printing* on page 9-5 for additional information.

**To print respiration waveforms:**

- Touch RECORD on the monitor.
- Touch the flashing RESP parameter key.

# Respiration Alarm Delays

*Table 2: Respiration Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Resp Rate High | 1 to 200 bpm | RR change from 20 to 40 BPM, limit 35 BPM<br>Less than 18 seconds |
| Resp Rate Low | 0 to 195 bpm | RR change from 20 to 10 BPM, limit 15 BPM<br>Less than 26 seconds |
| Apnea | | Apnea delay time + 3 seconds |

***Note:***

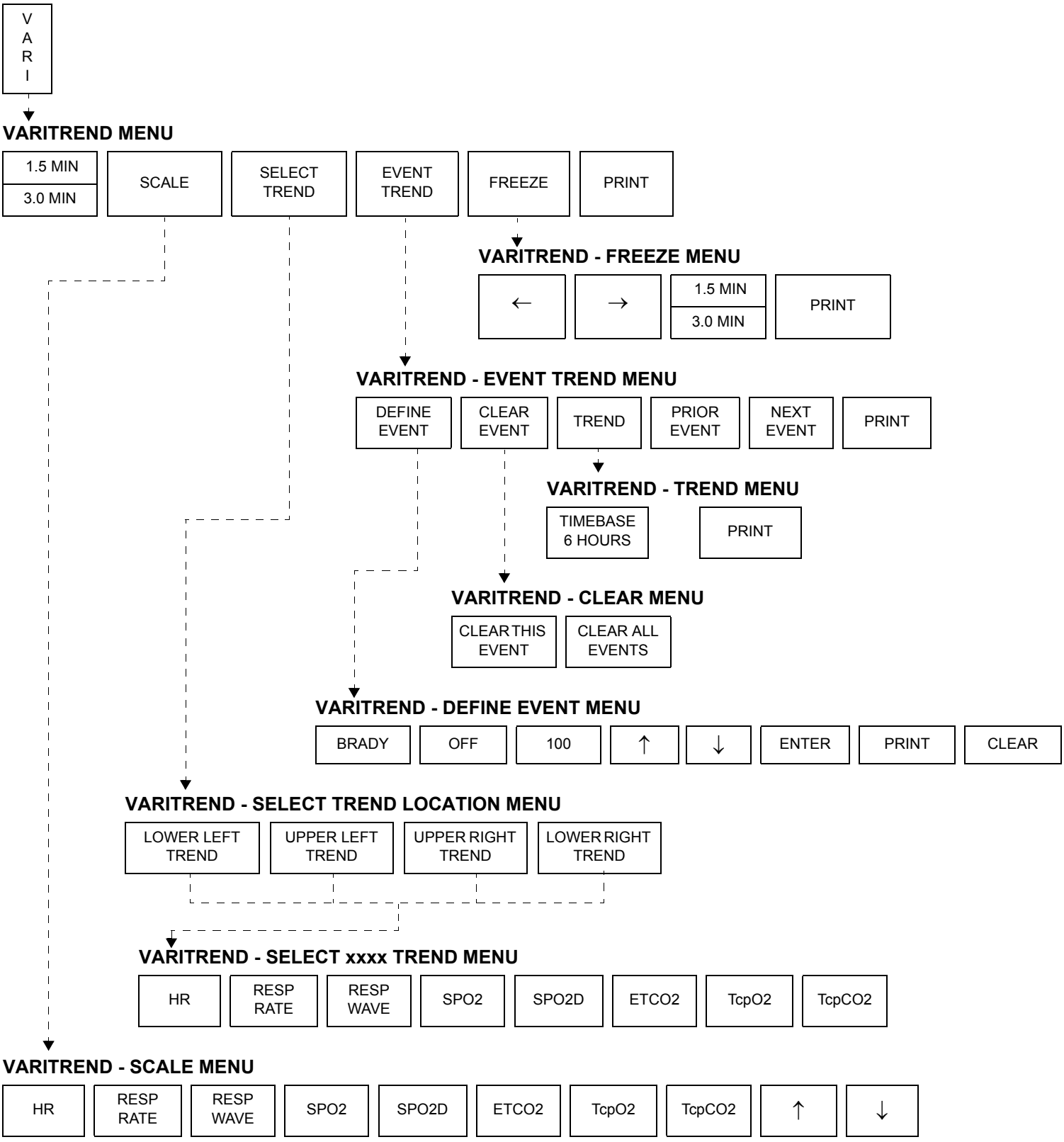
*Adult and neonate respiration alarm delays are the same.*

# Respiration Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Inaccurate respiratory rate or zero is displayed. Question marks are displayed instead of rate.** | ■ Respiration too shallow for normal detection. | ■ Touch the SHALLOW/NORMAL key to highlight SHALLOW. |
| | ■ ECG electrode contact or placement is poor. | ■ Apply new electrodes. Make sure to properly prepare the skin. Position electrodes on the chest where the chest expansion is the greatest. |
| | ■ Incorrect lead selection for respiration. | ■ Select the appropriate lead. Best lead selection is typically RA-LA for adults and RA-LL for infants. |
| | ■ CVA artifact. | ■ Assess the patient for apnea. Reselect lead for better signal quality. |
| **No respiration waveform. LOSS OF SIGNAL message appears.** | ■ ECG electrodes or patient cable not attached. | ■ Select another lead.<br>■ Reconnect the leads or the patient cable. |
| **No respiration waveform is displayed.** | ■ The module is not configured to display respiration. | ■ Select RESP ON in the **ECG Display Format** menu. |

# Varitrend

## Directory of Keys



# Varitrend

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## Introduction

Critical physiological events, such as apneas and bradycardias, are automatically trended and documented beat-by-beat and breath-by-breath with Varitrend. Events can be defined based on your standard care protocols or can be uniquely created for individualized patient care. A 24-hour trend of events is maintained, and up to 50 events are stored in memory.

Vital patient information is easy to see on the Varitrend graph. Place the cursor on the trend display and all numerical data for that time is immediately displayed, allowing you to efficiently assess the status of multiple parameters simultaneously. You can choose from: heart rate, respiration rate or compressed respiration waveform, oxygen saturation ($SpO_2$; pre- and post-ductal sites), end-tidal carbon dioxide ($EtCO_2$), transcutaneous carbon dioxide ($TcpCO_2$), and transcutaneous oxygen ($TcpO_2$).

## Configuring Varitrend Graphs

***Note:***

*If the VARITREND ON/OFF key does not appear in the **ECG Display Format** menu, your module does not include the Varitrend option.*

The Varitrend graph provides a real-time, continuous display of heart rate, respiration rate or compressed respiration waveform, $SpO_2$ (pre- and post-ductal sites), $EtCO_2$, as well as $TcpCO_2$, and $TcpO_2$. Up to four parameters can be displayed on the Varitrend graph.

**To turn Varitrend ON or OFF:**

- Touch ECG.
- Touch DISPLAY FORMAT.
- Select RESP / ON (if set to OFF).
- Select VARITREND / ON or OFF.

***Note:***

*To activate the Varitrend display, the RESP parameter must be enabled.*

## Setting the Varitrend Time Scale

The time scale for the horizontal axis can be set at either 1.5 or 3.0 minutes.

**To set the horizontal time scale:**

- Touch VARI.
- Select 1.5 MIN or 3.0 MIN.

## Selecting Parameters

You can assign specific parameters (up to four) to the Varitrend graph, as well as designate their placement on the graph. Use the SELECT TREND LOCATION menu to select a parameter for that location in the graph. Each parameter can be displayed in only one location at a time.

**To select trend location of parameters:**

- Touch VARI.
- Touch SELECT TREND.
- Touch one of the trend location keys.
- Select the parameter.

Parameter data can be configured to display in color-coded areas according to their selected location on the Varitrend graph. A parameter configured in the upper-left trend is color-coded cyan; the upper-right trend is green; the lower-right trend is blue; and the lower-left trend is magenta (refer to *Figure 15-1*). Depending on their designated location on the Varitrend graph, parameters may be correlated with the colors in other waveform zones (refer to *Setting Priorities and Colors* on page 3-8).

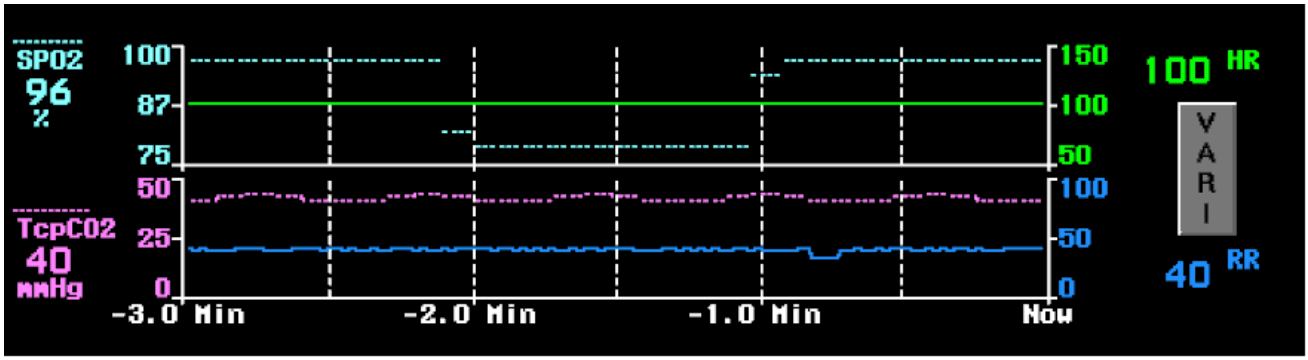



*Figure 15-1: Varitrend graph*

## Adjusting Varitrend Scales

Scales can be adjusted independently for respiration rate, heart rate, $SpO_2$ and $SpO_2D$, $ETCO_2$, $TcpO_2$, and $TcpCO_2$ trends. Scale selection units are the same as the trended parameter. Scale keys that are not associated with a currently trended parameter are not available for selection.

- Scale selections for the heart rate trend are 0-100, 0-150, 0-200, 0-250, 0-300, 50-150, 100-200, 100-250, or 100-300 beats per minute.
- Scale selections for the respiration rate trend are 0-50, 0-100, 0-150, or 0-200 breaths per minute.
- Scale selections for the respiration waveform are ±0.3, ±0.5, ±1.0, ±2.0, or ±6.0 ohms.
- Scale selections for the $SpO_2$ and SpO2D trends are 0-100%, 25-100%, 50-100%, and 75-100%.
- Scale selections for the $ETCO_2$ trend are 0-20, 0-40, 20-60, 40-80, and 60-100 mmHg, or 0-2, 0-6, 2-8, 5-11, and 8-14 kPa and 0-4, 0-8, 0-10, 0-12, and 0-16%.
- Scale selections for the $TcpO_2$ trend are 0-20, 0-50, 0-100, 0-200, 0-400, and 0-800, or 0-2, 0-6, 0-14, 0-26, 0-54, and 0-106 kPa.
- Scale selections for the $TcpCO_2$ trend are 0-20, 0-50, 0-100, and 0-200 mmHg, or 0-2, 0-6, 0-14, and 0-26 kPa.

***Note:***

*Only parameters that are currently being trended display a scale key on the SCALE MENU.*

**To adjust scales:**

- Touch VARI.
- Touch SCALE.
- Touch the parameter.
- Use the arrow keys to adjust the scale.

## Freezing the Varitrend Graph

The user can freeze the Varitrend graph to display a static view of the trends. To view the value of a parameter at a particular time, touch the trend graph. Use the arrow keys (← or →) to finely adjust the position of the cursor on the trend graph.

**To freeze events:**

- Touch VARI.
- Touch FREEZE.

**To move the cursor:**

- Touch the trend graph to move the cursor.
- Touch ← or → to adjust the the cursor position.

**To print the display:**

- Touch PRINT.

**To change the timebase of the display:**

- Touch the 1.5 MIN/3.0 MIN.

## Defining Events

The Event Trend feature captures events based on user selected criteria. A maximum of four criteria can be specified for each event definition. The criteria include: bradycardia (BRADY), tachycardia (TACH), APNEA, SPO2, SPO2D, ETCO2, $TcpO_2$, and $TcpCO_2$. Parameter criteria for up to five different events can be defined.

***Note:***

- *An event occurs if all the citeria for an event definition are met. Criteria for a parameter not monitored are ignored.*
- *If the module includes the Varitrend option, Varitrend events will be collected regardless of the Varitrend state, as long as RESP is ON.*




*Figure 15-2: Event definition*

**To define an event:**

- Touch VARI.
- Touch EVENT TREND.
- Touch DEFINE EVENT.
- Touch the event definition key (**1** through **5**) in the Varitrend zone.
- Touch the parameter key, then use the arrow keys to select the parameter.
- Touch the comparator key, then use the arrow keys to select <=, >=, or OFF.
- Touch the value key. Use the arrow keys to adjust the value.
- Touch ENTER.
- The event definition is updated in the Varitrend display zone.

**To clear an event definition:**

- Select the event definition key in the Varitrend zone.
- Touch CLEAR.

**To clear a criteria witihin an event definition:**

- Select the event definition key in the Varitrend zone.
- Touch the parameter key.
- Use the arrow keys to select the parameter criteria to be cleared.
- Touch the comparator key, then use the arrow keys to select OFF.
- Touch ENTER.

## Displaying Varitrend Events

When the criteria for an event are satisfied, a record of the parameters being monitored at that time is saved as a Varitrend event. Each Varitrend event can display up to four parameters. The parameters specified in the event definition are always shown in the Varitrend event, but additional parameters, if available, will be added, up to the maximum allowable, in the following order: heart rate, compressed respiration waveform (or respiration rate), $SpO_2$, $SpO_2D$ (second site), $EtCO_2$, $TcpO_2$, and $TcpCO_2$.

Touch EVENT TREND to display the current Varitrend event. To review additional Varitrend events, touch PRIOR EVENT or NEXT EVENT.

**To display events:**

- Touch VARI.
- Touch EVENT TREND.
- Touch PRIOR EVENT or NEXT EVENT.

## Displaying Event Trends

Events are trended according to their duration and frequency. Regardless of the defining criteria, all events are grouped together in the Event Trend graph (refer to *Figure 15-3*). Trends can be reviewed in in 6-, 12-, or 24-hour time periods.

**The resolutions for these timebases are:**

- 15 minutes for a 6-hour trend
- 30 minutes for a 12-hour trend
- 60 minutes for a 24-hour trend

The top trend displays the duration of the longest event in each time period. The bottom trend displays the number of events that occurred during each time period. Scaling, for the vertical axis for each trend, is automatically adjusted based upon patient data.




*Figure 15-3: Event Trend graph*

***Note:***

*Events longer than four minutes are reported as four-minute events.*

**To display event trends:**

- Touch VARI.
- Touch EVENT TREND.
- Touch TREND.

**To print event trends:**

- Touch VARI.
- Touch EVENT TREND.
- Touch PRINT.

  -OR-
- Touch TREND and then touch PRINT.

## Clearing Events

When a single event is cleared, the data that represents that episode is removed from the event trends. All events and trends can be cleared. This has no effect on the event definitions.

**To clear events:**

- Touch VARI.
- Touch EVENT TREND.
- Touch CLEAR EVENT.
- Select CLEAR THIS EVENT or CLEAR ALL EVENTS.

# Printing Varitrend Graphs

The user can print the currently displayed Varitrend graph. Refer to *Printing* on page 9-5 for a complete overview of printer functions.

**To print a Varitrend graph:**

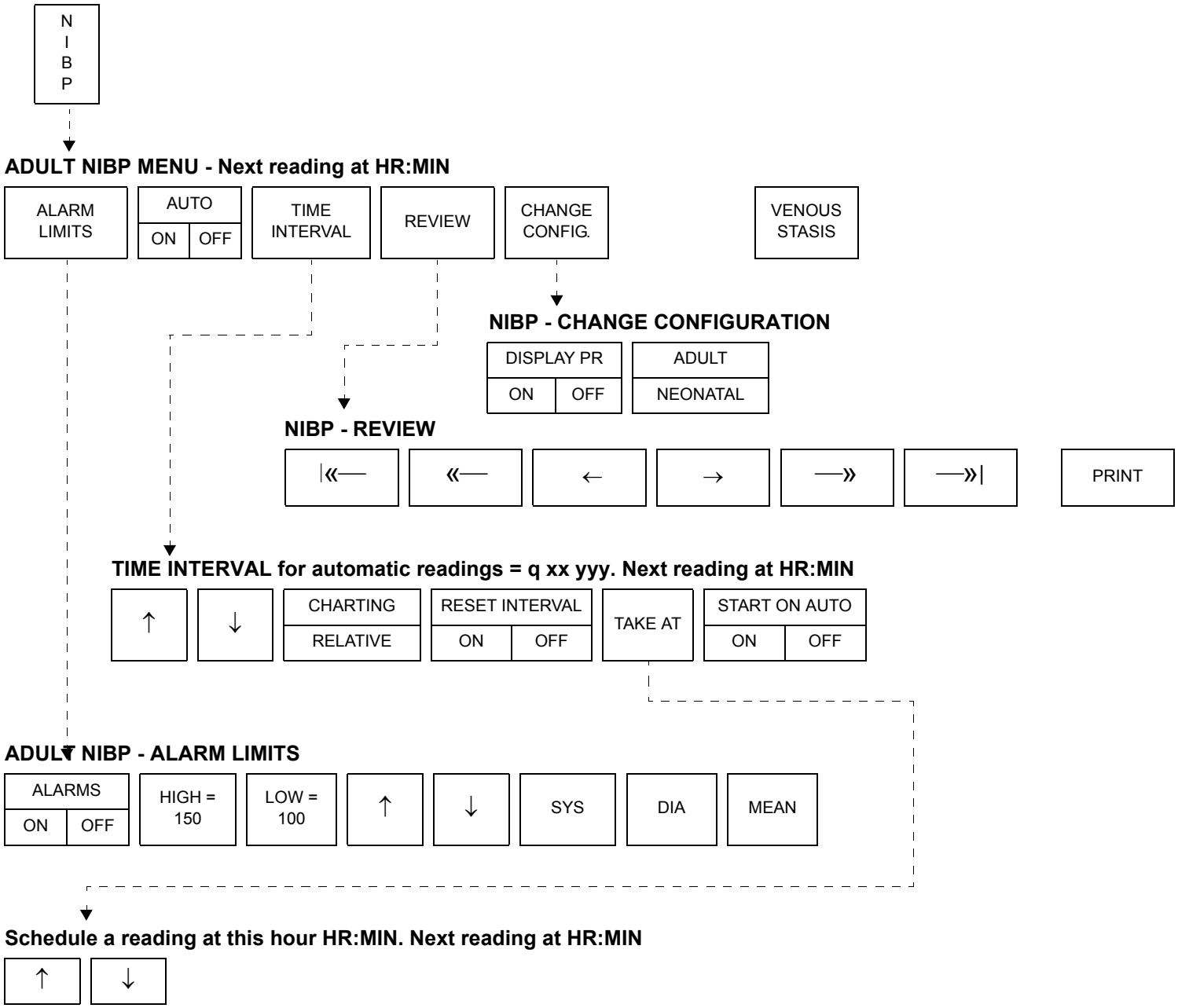
- Touch VARI.
- Touch PRINT.

# Varitrend Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **A critieria cannot be added to a Varitrend event definition.** | ■ No event is selected. | ■ Select an event to define, **1** through **5**. |
| | ■ Four criteria are alredy selected for that event. No others can be added. | ■ Remove one criteria from the event definition, then add the desired criteria.<br>■ Select another event to define, then add the desired criteria. |
| | ■ BRADY or TACH are already defined. | ■ Select BRADY or TACH. These criteria are mutually exclusive. |
| **The Varitrend key (VARI) is unavailable.** | ■ RESP channel is not enabled. | ■ Touch ECG, touch DISPLAY FORMAT, then touch RESP. |

# NIBP

## Directory of Keys



# NIBP

## Contents

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## Overview

Noninvasive blood pressure (NIBP) uses oscillometric monitoring to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures. All monitors display the most recent reading with the time that reading was initiated.

Bedside monitors store up to 120 readings and display a table of up to ten readings at one time (five readings if the pulse rate is displayed). Additional readings can be viewed by scrolling through additional pages of measurements.

***Note:***

- *Blood pressure measurements determined with this module are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultatory method, within the limits prescribed by the American National Standards Institute, with electronic or automated sphygmomanometers.*
- *Use only cuffs specified by Spacelabs Healthcare. Other cuffs may adversely affect performance and measurement accuracy.*
- *There are no hazards associated with using noninvasive blood pressure equipment during defibrillation or high-frequency electrosurgery, because both the cuff and cuff tubing are made of non-conductive materials.*
- *To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to noninvasive blood pressure measurements. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to several physiological parameters or to the monitoring system itself.

***Warning:***

- ***During NIBP readings, the inflated cuff reduces blood flow to the limb to which it is applied. Consider this when taking frequent manual NIBP readings or when short time intervals for automatic NIBP readings are used. Check the patient periodically to ensure that the cuff does not impair limb circulation.***
- ***Do not apply a cuff to a limb with restricted blood flow, such as a patient with a dialysis shunt or history of mastectomy.***
- ***Do not apply the cuff to any extremity being used for intravenous infusion or catheterization.***
- ***Do not apply the cuff to any area of breached or injured skin.***

**Caution:**

- **Use only specified extensions or adapters with the neonatal inflation tubing.**
- **Avoid compression or restriction of pressure in the NIBP patient connector tubes.**
- **The mode selected (ADULT or NEONATAL) must correlate with the type of patient wearing the cuff that connects to the hose connected to the module.**

# Selecting ADULT or NEONATAL Mode

The patient type selected in NIBP does not affect (and is not affected by) the patient type selected when admitting a patient. In modules that offer both ADULT and NEONATAL modes, you can determine the current mode by observing which key is highlighted or by reading the menu prompt in the **NIBP** menu.

**To select the patient type:**

- Touch NIBP.
- Touch CHANGE CONFIG.
- Select ADULT or NEONATAL.

**The following events occur with each change of mode:**

- Active NIBP alarm violations end.
- Alarm limits and status (ON/OFF) automatically change to reflect the new mode (ADULT or NEONATAL).

# Setting Up NIBP Monitoring

Proper cuff selection and application are essential in ensuring the accuracy of NIBP readings. Improper cuff selection results in the greatest chance of error, therefore, a variety of cuff sizes should be available to accommodate your full patient population. If the cuff is too wide for the patient, the reading will be falsely lowered. If the cuff is too narrow for the patient, the reading will be falsely elevated.

To select the proper cuff, first measure the circumference of the limb (in centimeters) at its midpoint. Match the limb measurement to the circumference range specified on each cuff. When applied, the index line on a correctly sized cuff will fall within the designated range markings on the cuff.

The cuff should be snugly applied. When the cuff is properly applied, you should be able to insert one finger between the cuff and the limb. If you can insert two fingers, the cuff is too loose, which may result in falsely elevated readings. Ensure that the inflation tubing is not kinked or occluded when the cuff is applied.

**To set up NIBP monitoring:**

- Attach the cuff to the cuff tubing.
- Attach the cuff tubing to the appropriate connector on the front panel of the module.
- Attach the cuff to the patient.
- Touch NIBP.
- Touch additional display keys as needed.

## Patient Factors Affecting Readings

Applying external pressure to the cuff during readings, excessive patient movement, speech, or muscle contractions (as a result of severe pain or shivering) can interfere with NIBP readings. Ensure that the patient is quiet and not moving during NIBP readings, just as you would during manual readings. Institute measures to minimize shivering and alleviate pain, if necessary.

Pressure also varies cyclically with normal respiration. With deep respirations, or in certain patients, this effect may be enhanced, increasing the variability of NIBP readings.

Obtaining NIBP readings can be more difficult in patients with arrhythmias. These arrhythmias increase the beat-to-beat pressure fluctuations during readings, which increases the variability of the NIBP readings. Temporarily verify pressure using another method if it becomes difficult to obtain readings in the presence of arrhythmias.

For patients in shock, indirect methods of measuring pressure (auscultatory, oscillometric, doppler) may not be reliable because of peripheral vascular changes. These changes include peripheral vasoconstriction and diminished peripheral circulation because of shunting of blood to central organs. In some cases, peripheral pulses or Korotkoff sounds may be diminished or disappear in spite of adequate blood pressure. In such cases, measuring a cuff pressure may be impossible or give misleading results. Direct (invasive) blood pressure measurements should be considered in patients with signs of shock or in any patient who rapidly becomes unstable for unknown reasons.

# Display Detail

*Figure 16-1* and *Figure 16-2* illustrate typical NIBP views. You can view the most recent NIBP reading from any bedside or central monitor on a network.

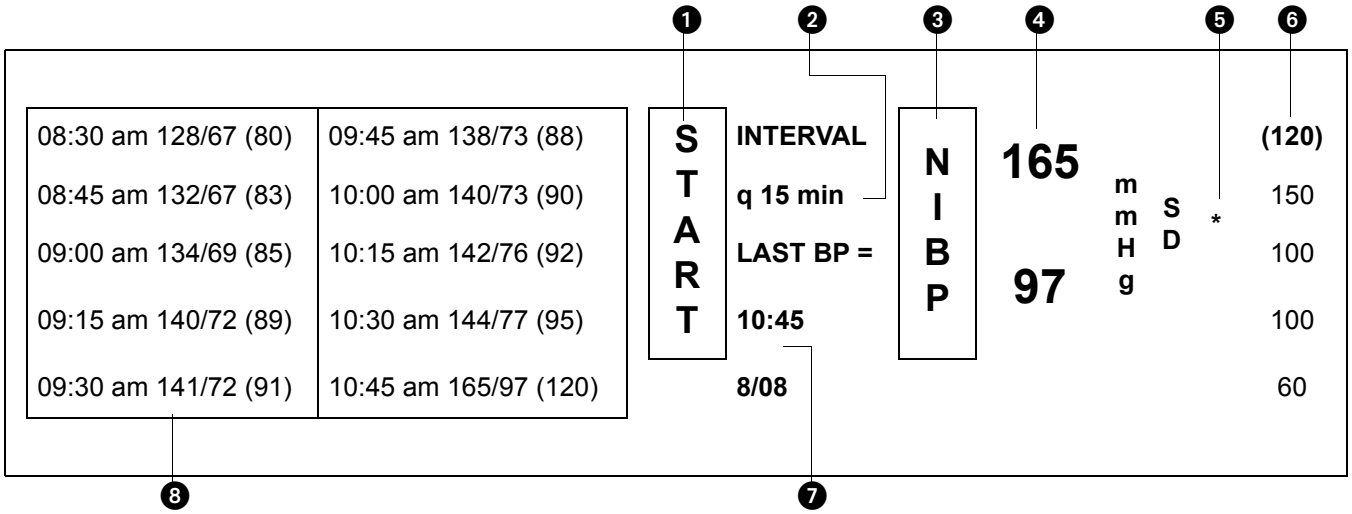



*Figure 16-1: Bedside monitor*

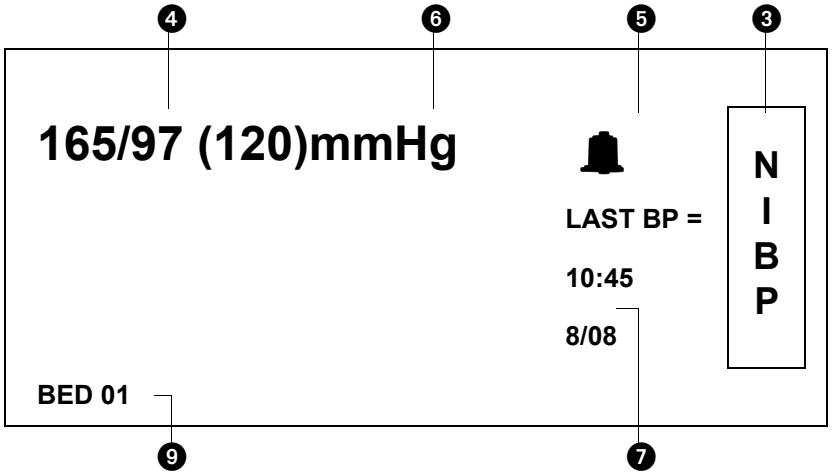



*Figure 16-2: Split-view central monitor*

1. The START key initiates an immediate blood pressure measurement. While a measurement is in progress, the key changes to STOP.
2. Current interval for automatic readings (q 15 minutes). A **q'** in place of a **q** indicates that the reduced delay of five seconds between readings is active (refer to *Automatic NIBP Measurements* on page 16-10).
3. NIBP parameter key

❹ Last systolic and diastolic readings

❺ NIBP alarm limits. Split-view central monitors display a bell symbol when alarms are enabled. Bedside monitors display the high and low alarm limits for systole and diastole. The asterisk indicates that alarms are enabled for mean pressure.

❻ Mean reading

❼ Time and date of the last reading

❽ NIBP measurement table (bedside monitors only)

❾ Bed/patient ID

***Note:***

*If you remove one NIBP module and insert another without purging data (via the Admit/Discharge function), the NIBP table may display data for two patients.*

The NIBP measurement table can display readings with or without a pulse rate. Ten measurements are displayed on each page of the NIBP table unless you choose to display the pulse rate. If the pulse rate is displayed, five measurements are displayed on each page of the NIBP table. Pulse rate is obtained from ECG, arterial pressure (ART), $SpO_2$, and NIBP (in that order), depending on the availability of these parameters.

# Reviewing NIBP Readings

**To display pulse rate on the NIBP table:**

- Touch NIBP.
- Touch CHANGE CONFIG.
- Select DISPLAY PR / ON.

**To review NIBP measurements:**

- Touch NIBP.
- Touch REVIEW.

Bedside monitors display a chronological listing of NIBP readings with the oldest data at the top of the left column. Each reading contains the time of the measurement and the pressure values for systolic, diastolic, and mean. As new measurements are taken, the oldest data moves off the display line-by-line.

You can review a patient's NIBP measurements by scrolling through the measurement table line-by-line or page-by-page. To scroll line-by-line, touch the single-arrow keys.

**To scroll page-by-page, touch the double-arrow keys:**

- To review earlier measurements, touch the ← key or the «— key.
- To review later measurements, touch the → key or the —» key.

Touch the |«— key to display the earliest page of readings.

Touch the —»| key to display the latest page of readings.

***Note:***

*Because monitors display a full page of readings, some readings may appear on multiple pages when more than 5 or 10 NIBP measurements have been taken.*

# Printing NIBP Readings

**You can print the NIBP data in the following formats:**

- Multiple readings
- NIBP data for the last reading only

**To print the NIBP measurements currently displayed:**

- Touch NIBP.
- Touch REVIEW.
- Touch PRINT.

**To print the most recent measurement (no table):**

- Touch the RECORD function key.
- Touch NIBP.

# Taking NIBP Readings and Venous Stasis

**At the beginning of a blood pressure measurement:**

- The mean value of the previous reading disappears.
- The message *READING IN PROGRESS* replaces the diastolic value.
- A bleed step replaces the previously displayed systolic pressure.

If the system fails to complete an initial measurement reading, the message *SECOND READING REQUIRED* appears, along with a description of the cause of the failure. A second measurement attempt automatically begins after a short delay. The cuff must be deflated for at least 30 seconds (5 seconds in short-term AUTO mode) before a new reading can be initiated.

**If the second attempt fails:**

- The message *NO READING* appears.
- An alarm tone sounds (if alarms are turned ON and NO READING is set to sound a tone, as set in the Module Configuration Manager).

- One of the following messages appears:

  *INFLATE ERROR*

  *HW ERROR*

  *NO DATA*

**If the system detects unstable beat-to-beat blood pressures during measurements, one of the following messages appears:**

- *MOTION (NEONATAL mode)*
- *ARTIFACT (ADULT mode)*

***Warning:***

***During NIBP readings, the inflated cuff reduces blood flow to the limb to which it is applied. Consider this when taking frequent manual NIBP readings or when short time intervals for automatic NIBP readings are used.***

## Deflating the NIBP Cuff

If you deflate the cuff during a reading, the reading ends and the messages *NO READING* and CUFF DEFLATE appear on the monitor.

**To stop an NIBP measurement (or venous stasis) in process:**

- Touch STOP.
  -OR-
- Press the red Deflate button on the module.

If AUTO is set to ON, the next automatic measurement will start at the next scheduled interval after the completion of manual NIBP measurements or venous stasis.

## Manual NIBP Measurements

Touch the START key (refer to *Figure 16-1* on page 16-6) to start a measurement. If another measurement is already in progress, this key is labeled STOP.

**To start a manual measurement, touch START.**

# Automatic NIBP Measurements

Use the TIME INTRVAL key to select a time interval for an automatic measurement. The current time interval for automatic measurements is displayed above the arrow keys and in the NIBP zone.

**To determine automatic measurement intervals:**

- Touch NIBP.
- Touch TIME INTRVAL.
- Use the arrow keys to adjust the interval.

## Measurement Intervals

**Measurement intervals are as follows:**

- 1, 2, 3, 4, 5, 10, 15, 20, and 30 minutes
- 1, 2, 4, 6, or 8 hours

For time intervals of less than five minutes, special allowances are made for a rapid succession of readings. For the first 15 minutes after you set up a reading (turn AUTO MODE ON or select a new time interval), the minimum delay between readings is five seconds (this is the short-term AUTO mode).

When this five-second delay is active, the interval message appears with an apostrophe after the **q** (**q'**). After the 15-minute period, the minimum delay between automatic readings becomes 30 seconds. However, you can touch START at any time to take a reading, and it will have a maximum delay of 5 seconds.

## Automatic Measurement Modes (AUTO MODE)

You can press a key on the **Time Interval** menu to select either Charting Mode or Relative Mode. You can select Charting Mode or Relative Mode whether automatic NIBP measurements are turned ON or OFF. AUTO MODE will not be activated until NIBP measurements are turned ON.

If automatic measurements are turned ON, the time of the next scheduled reading appears in the prompt line, and a reading may be taken immediately (refer to *START ON AUTO* on page 16-12). If automatic readings are turned OFF, the message NO READING appears on the prompt line.

## Charting Mode

When the CHARTING key is selected, all automatic NIBP readings are synchronized to start at the next even time interval conducive for charting. For example, if a 15-minute interval was selected, and the current time is 14:07, automatic readings would be initiated at 14:15, 14:30, 14:45, and 15:00.

## Relative Mode

When the RELATIVE key is selected, automatic NIBP readings are synchronized to when AUTO was turned ON or the last manual NIBP measurement. For example, if a 15-minute interval was selected and AUTO was turned ON at 8:57, readings would be initiated at 9:12, 9:27, 9:42, and 9:57.

**To select Charting or Relative Mode:**

- Touch NIBP.
- Touch TIME INTRVAL.
- Touch CHARTING/RELATIVE.

***Note:***

- *If the system time is changed by 10 minutes or less, automatic readings are not rescheduled. However, if a reading will be missed due to the time change, that reading will be taken immediately.*
- *If the system time is changed by more than 10 minutes, the time of the next blood pressure measurement is recalculated. Any reading that would have been skipped by changing the time is not taken.*
- *If the system time is changed, and CHARTING is selected, the reading will occur at the next scheduled time.*
- *If the system time is changed, and RELATIVE is selected, the reading is scheduled from the new time, just as if the interval were changed.*

## RESET INTERVAL

The RESET INTERVAL key is only available when Relative Mode is selected. If the RESET INTERVAL key is ON, the automatic NIBP measurement interval is reset whenever a manual NIBP measurement is initiated.

For example, if the automatic interval is 15 minutes, and if readings are automatically taken at 8:05 and 8:20, and then the caregiver initiates a manual NIBP measurement at 8:30, the next automatic reading would be at 8:45. If the RESET INTERVAL key is OFF, taking the manual NIBP measurement has no effect, and the next automatic reading would be taken at 8:35.

**To turn Reset Interval ON:**

- Touch NIBP.
- Touch TIME INTRVAL.
- Touch RESET INTERVAL / ON.

## TAKE AT

The TAKE AT key is enabled with Charting Mode, when the NIBP measurement interval is two hours or greater. Touching the TAKE AT key opens a new menu with two arrow keys. Use the arrow keys to schedule an hour for an NIBP measurement.

For example, if a four-hour interval is selected in Charting Mode, and TAKE AT is set to 5:00, the NIBP measurement will be scheduled at 5:00, 9:00, and so on.

**To schedule an NIBP measurement using TAKE AT:**

- Touch NIBP.
- Touch TIME INTRVAL.
- Use the arrow keys to adjust the interval.
- Touch CHARTING.
- Touch TAKE AT.
- Use the arrow keys to select the time of the NIBP measurement.

### START ON AUTO

The START ON AUTO key determines whether or not a blood pressure reading is immediately taken when the automatic NIBP readings are initially turned ON or set to ON.

However, setting the START ON AUTO key to ON will not cause a reading to be taken when the reading interval set in Charting Mode is changed (the reading is already scheduled to occur).

**To enable START ON AUTO:**

- Touch NIBP.
- Touch TIME INTRVAL.
- Touch START ON AUTO.

## Venous Stasis

The venous stasis feature uses the NIBP cuff as the tourniquet for venous cannulation.

**When enabled in the Module Configuration Manager, the cuff is inflated and pressure is held constant as follows:**

- Neonatal — 40 mmHg for one minute
- Adult — 60 mmHg for two minutes

If the mean arterial pressure (MAP) of the last blood pressure is less than 50 mmHg (neonatal) or 70 mmHg (adult), the stasis cuff pressure will be 10 mmHg below the MAP.

***Note:***

*The VENOUS STASIS key displays if the venous stasis feature is enabled.*

**To start venous stasis:**

- Touch NIBP.
- Touch VENOUS STASIS.

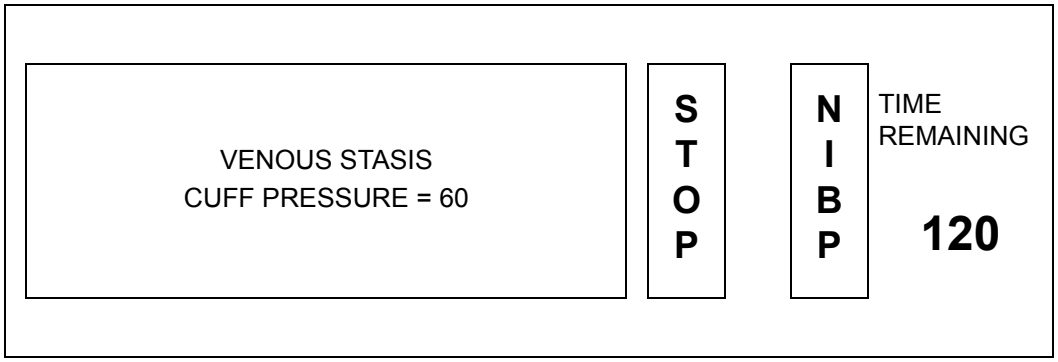



*Figure 16-3: Venous stasis display*

**When venous stasis begins:**

- The START key changes to STOP.
- The cuff inflates to a constant pressure (as previously noted).
- The NIBP measurements table is replaced by the words VENOUS STASIS and CUFF PRESSURE. The cuff pressure value updates every three seconds.
- The time remaining in seconds displays to the right of the NIBP parameter key. When the stasis pressure is reached, the timer starts counting down in five-second intervals until it reaches 15 seconds.
- During the last 15 seconds of the stasis, the words VENOUS STASIS flash to advise of the limited time remaining, and the timer decrements in one-second intervals.
- When the timer counts down to zero, the cuff automatically deflates, the STOP key changes to START, and the NIBP measurements table is restored.

# Enabling and Adjusting Alarms

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To enable and adjust alarms:**

- Touch NIBP.
- Touch ALARM LIMITS.
- Select SYS, DIA, or MEAN.
- Select ALARMS / ON.
- Select HIGH= or LOW=.
- Use the arrow keys to adjust.

# NIBP Alarm Delays

*Table 1: NIBP Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Systolic Low | • Adult 30 to 255 mmHg<br>• Neonatal 15 to 135 mmHg | Less than 3 seconds after completion of measurement |
| Systolic High | • Adult 35 to 260 mmHg<br>• Neonatal 20 to 140 mmHg | Less than 3 seconds after completion of measurement |
| Diastolic Low | • Adult 30 to 255 mmHg<br>• Neonatal 15 to 135 mmHg | Less than 3 seconds after completion of measurement |
| Diastolic High | • Adult 35 to 260 mmHg<br>• Neonatal 20 to 140 mmHg | Less than 3 seconds after completion of measurement |
| Mean Low | • Adult  30 to 255 mmHg<br>• Neonatal 15 to 135 mmHg | Less than 3 seconds after completion of measurement |
| Mean High | • Adult 35 to 260 mmHg<br>• Neonatal 20 to 140 mmHg | Less than 3 seconds after completion of measurement |

# NIBP Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No NIBP display key is displayed** | ■ Module is not inserted correctly. | ■ Remove and re-insert the module. |
| **No NIBP readings can be obtained** | ■ Incorrect or inoperative cuff is in use. | ■ Replace with a cuff known to be operative. |
| | ■ Cuff tubing is attached to an adult connector, but the monitor is configured in NEONATAL mode (or vice versa). | ■ Connect the tubing to the correct connector. Correlate MONITOR mode, cuff, and patient type. |
| | ■ Tubing is kinked. | ■ Locate the kink and straighten the tubing. |
| | ■ Some arrhythmias (for example, atrial fibrillation and frequent ventricular ectopy) may cause a single or repeated failure to obtain a reading (may be because of true beat-to-beat variations in pressure). | ■ Document arrhythmia, if present, verify pressure with another method, then follow hospital procedure for care of this type of patient. |
| | ■ Excessive patient motion or muscle contractions associated with shivering or severe pain. | ■ Ensure patient is quiet with minimal movement during NIBP readings. Minimize the patient's shivering. |
| | ■ Blood pressure is outside of the measurement range. | ■ Verify extremely high or low pressures with another method. |
| **Intermittent or complete failure to operate** | ■ Hardware error (codes 10, 20, and 30) detected during previous measurement. | ■ Check for the presence of the RESET NIBP key in the **Change Configuration** menu. Touch RESET NIBP to re-enable monitoring. |
| | | ■ Remove the module from service and call your biomed a qualified field service engineer if this condition occurs repeatedly. |

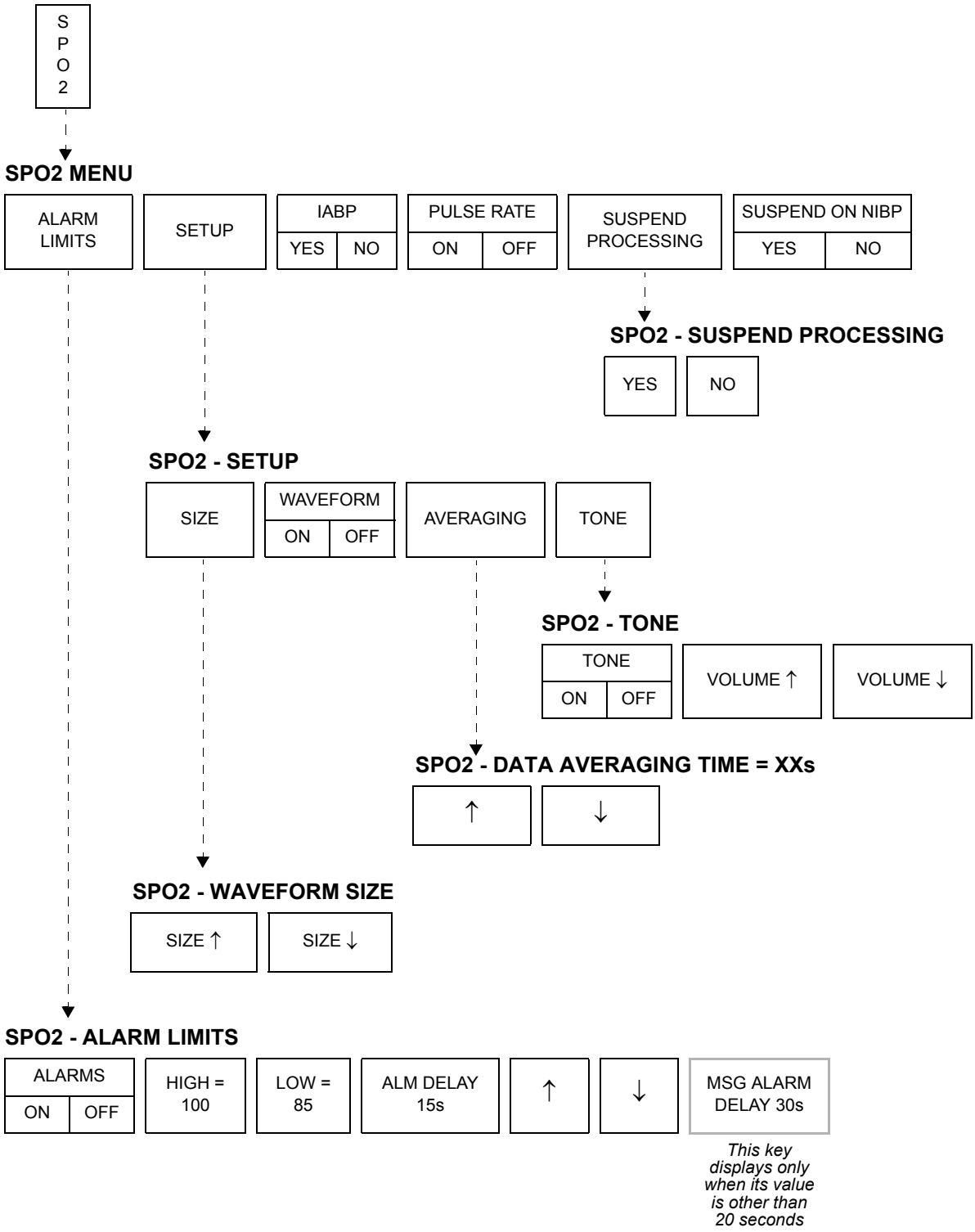
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Intermittent or complete failure to operate (continued)** | ■ Hardware error causing the NIBP portion of the module to be inoperable. The *NIBP SYSTEM FAULT ERROR NO. = XX* (bedside monitor only) or *HW ERROR* (bedside monitors and remote monitors) message appears. | ■ Check for the presence of the RESET NIBP key in the **Change Configuration** menu. Touch RESET NIBP to re-enable monitoring.<br>■ Remove the module from service and call your biomed or a qualified field service engineer if this condition occurs repeatedly. |
| **CUFF CANNOT BE DEFLATED** | ■ The deflate hardware is blocked and the cuff cannot be deflated. | ■ Check for the presence of the RESET NIBP key in the **Change Configuration** menu. Touch RESET NIBP to re-enable monitoring.<br>■ Remove the cuff from the limb immediately and have the module serviced by biomed or a qualified field service engineer. |
| **Apparent incorrect value** | ■ Wrong size cuff for patient. | ■ Measure patient's limb at the midpoint. Match limb measurement to the range specified on the cuff (undersizing the cuff results in the greatest degree of error). |
| | ■ Cuff is damaged. | ■ Replace with a good cuff. |
| | ■ Excessive patient motion, shivering, or severe pain. | ■ Ensure that the patient is quiet with minimal movement during NIBP readings. Minimize the patient's shivering and pain. |
| | ■ False high readings may be the result of venous congestion caused by frequent readings. | ■ Reduce the frequency of the readings. |
| | ■ Cuff too loose or positioned incorrectly. | ■ Tighten the cuff or reposition it appropriately. |

## NIBP

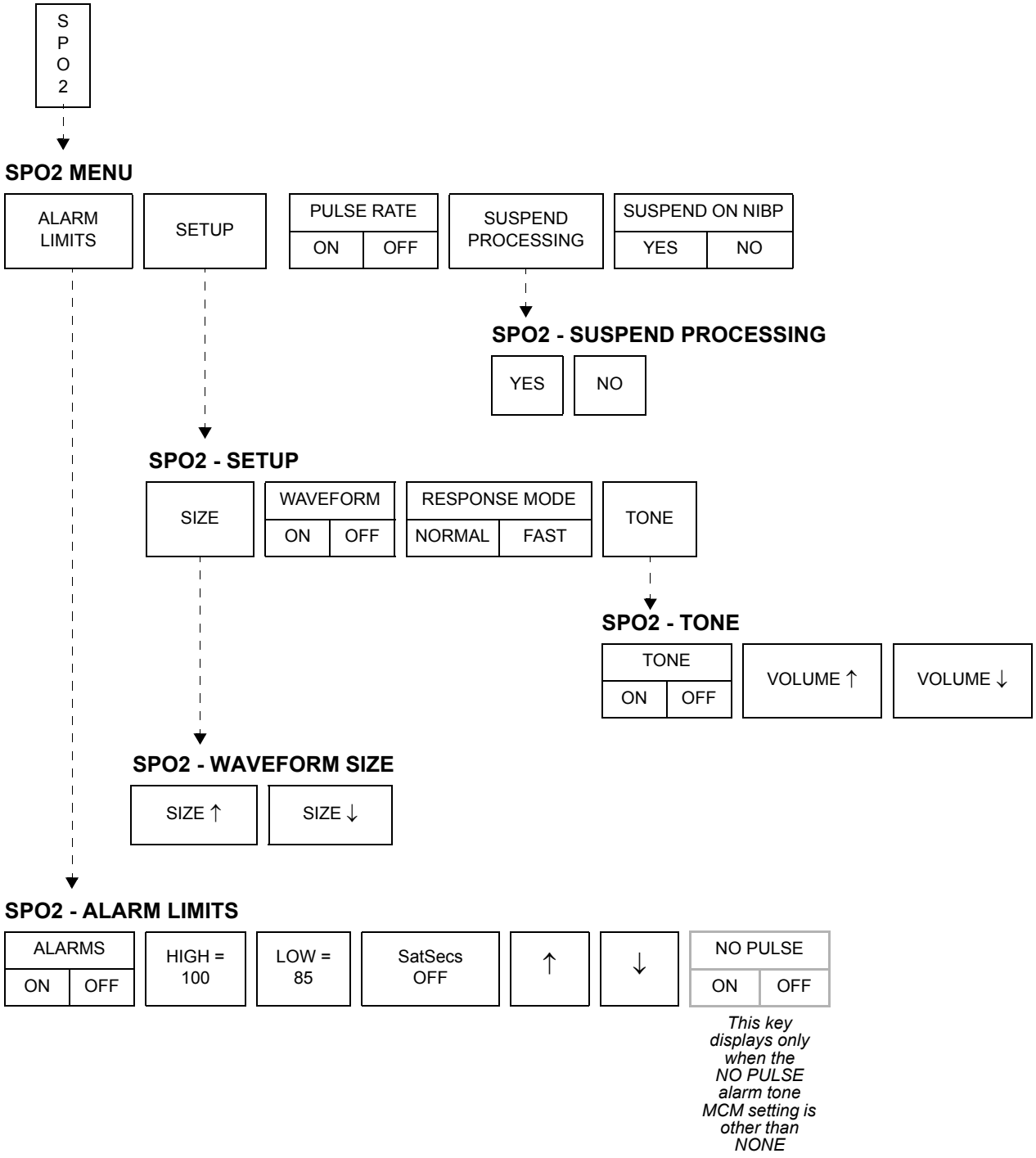
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Variable readings occur** | ■ Some arrhythmias may cause beat-to-beat pressure variations between NIBP readings. | ■ Document the arrhythmia, if present. Verify the pressure using another method, then follow hospital procedure for care of this type of patient. |
| | ■ Larger than normal influence of respiratory phases on blood pressure (inspiratory fall in blood pressure; expiratory rise). | ■ NIBP software usually compensates for normal variation. |
| **No NIBP readings or questionable values in the presence of shock** | ■ Peripheral vascular changes experienced during shock may reduce the reliability of blood pressure readings obtained with any indirect method. Peripheral pulses may be diminished or absent. | ■ Consider invasive pressure measurements in patients with symptoms of shock or in any patient who rapidly becomes unstable for unknown reasons. |

# $SpO_2$

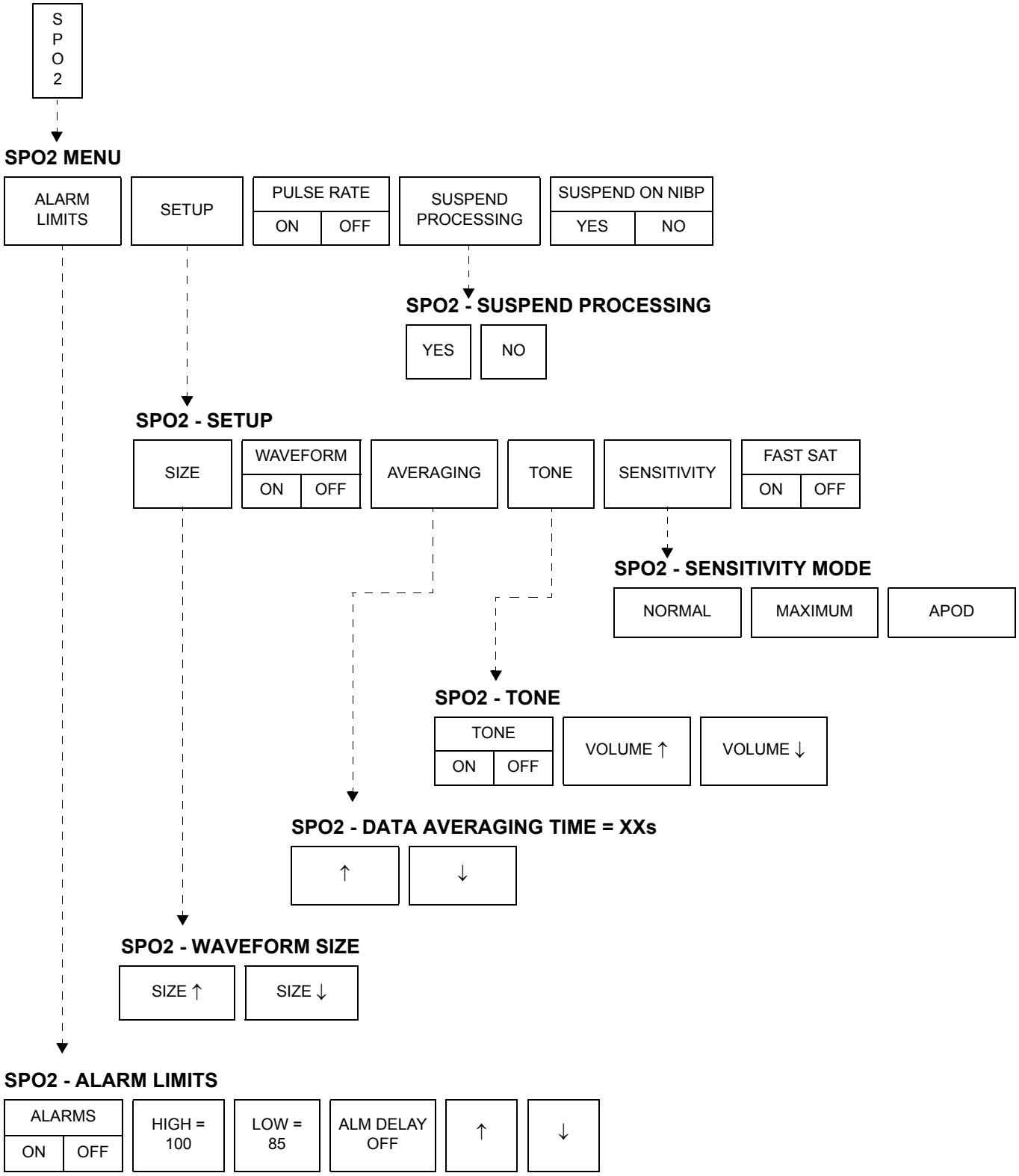
## Directory of Keys — Spacelabs Healthcare $SpO_2$ Technology



# Directory of Keys — Nellcor OxiMax $SpO_2$ Technology



# Directory of Keys — Masimo SET $SpO_2$ Technology



# $SpO_2$

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## Overview

Pulse oximetry is used to continuously and noninvasively measure functional oxygen saturation in the blood. Pulse oximetry is measured by using changes in light absorption, as the light passes over a pulsating arteriolar bed. Pulse oximetry is also used to continuously and noninvasively measure pulse rate, using an $SpO_2$ sensor.

The pulse oximetry sensor contains two light-emitting diodes (LEDs). These LEDs emit specific wavelengths of red and infrared light, which are measured by a photo detector. The monitor displays this functional oxygen saturation as percent $SpO_2$.

The amount of light absorbed by the arteriolar bed varies during pulsations. During systole, a pulse of arterial blood enters the vascular bed, increasing the blood volume and light absorption. During diastole, blood volume and light absorption reach their lowest point. The pulse oximeter's $SpO_2$ measurement depends on the difference between the maximum and minimum absorption (systole and diastole, respectively).

# Traditional Pulse Oximetry

**Traditional pulse oximetry is based on two principles:**

- Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (spectrophotometry).
- The volume of arterial blood in tissue and the light absorbed by the blood changes during the pulse (plethysmography).

Traditional pulse oximetry assumes that all of the pulsations in the light absorbance signal are due to oscillations in the arterial blood volume. Therefore, the blood flow in the region of the sensor passes entirely through the capillary bed. Concentrating on the light absorption of pulsatile arterial blood eliminates the effects of non-pulsatile absorbers (such as bone, tissue, pigmentation, and venous blood), which normally absorb a constant amount of light over time.

Oxyhemoglobin and deoxyhemoglobin differ in light absorption. The amount of red and infrared light absorbed by blood can be used to calculate the ratio of oxygenated hemoglobin to total hemoglobin in arterial blood, at each of two wavelengths (such as 660 nm and 940 nm). This ratio is translated into the functional oxygen saturation ($SpO_2$) measurement that the monitor displays.

***Note:***

- *Because $SpO_2$ measurements depend upon light from a sensor, excessive ambient light can interfere with the pulse oximeter's measurements.*
- *This pulse oximeter measures functional saturation, which is essentially the percentage of hemoglobin that can transport oxygen (oxyhemoglobin). Pulse oximeters do not detect significant amounts of dysfunctional hemoglobins, such as carboxyhemoglobin or methemoglobin, which cannot carry oxygen. Saturation measurements from pulse oximeters cannot be directly compared to measurements from a laboratory co-oximeter. Co-oximeters provide a fractional saturation ($SaO_2$) value by measuring each type of hemoglobin individually. This fractional value is the ratio of oxygenated hemoglobin to all measured (oxygenated and dysfunctional) hemoglobins.*
- *A pulse oximeter $SpO_2$ measurement may not match the saturation calculated from a blood gas partial pressure of oxygen ($PO_2$). The most likely reason is that the calculated saturation value was not corrected to reflect the effects of variables that alter the relationship of $PO_2$ and pH. Such variables can include temperature, the partial pressure of carbon dioxide ($PCO_2$), 2,3-DPG, and fetal hemoglobin.*

Monitoring of two $SpO_2$ sites, if clinically necessary, may be accomplished by inserting a second $SpO_2$ module into an available slot in the monitor or module housing. The new parameter displays below the first $SpO_2$ channel. Affix a label to the monitor's bezel to indicate the sensor site location (for example, right hand, left foot) for each $SpO_2$ parameter displayed on the monitor. Take care to ensure that the two sensors remain apart so that they do not interfere with each other's measurements.

**During magnetic resonance imaging (MRI) procedures, do not use the pulse oximeter or oximetry sensors, for the following reasons:**

- the pulse oximeter may interfere with the MRI procedure;
- the MRI unit may affect the accuracy of the oximetry measurements; and
- the MRI unit may potentially cause burns due to induced current.

Refer to your hospital's protocols for specific instructions.

## Masimo SET-Based Pulse Oximetry

Masimo SET-based pulse oximetry assumes that some of the blood flows through arterio-venous shunts rather than entirely through the capillary bed. This shunting is highly variable, and the fluctuating absorbance by venous blood is the major component of noise during the pulse.

Masimo SET pulse oximeters assume that the signals measured at the two wavelengths consist of both an arterial component and a noise component. The Masimo SET algorithm removes the noise component before calculating the functional oxygen saturation that the monitor displays.

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to $SpO_2$. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

***Warning:***

- ***A pulse oximeter should be considered an early warning device and should NOT be used as an apnea monitor. If a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.***
- ***Pulse rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect certain arrhythmias. The pulse oximeter should not be used as a replacement or substitute for ECG-based arrhythmia analysis.***
- ***Carboxyhemoglobin may erroneously increase readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes or any substance containing dyes that change usual arterial pigmentation may cause erroneous readings.***
- ***Inaccurate measurements may be caused by:***
  - ***Significant levels of dysfunctional hemoglobins (e.g., carboxyhemoglobin or methmoglobin).***
  - ***Intravascular dyes such as indocyanine green or methylene blue.***
  - ***Exposure to excessive illumination, such as surgical lamps (especially ones with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight (exposure to excessive illumination can be corrected by covering the sensor with a dark or opaque material).***
  - ***Venous pulsations.***
  - ***Placement of a sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line.***
- ***Do not use the oximetry sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns.***
- ***Sensors have no adverse effect on tissues when used according to the directions for use provided by the sensor manufacturer.***

- ***Tissue damage can be caused by incorrect application or by wrapping the sensor too tightly for example. Inspect the sensor site as directed in the sensor directions for use to ensure skin integrity and to ensure correct positioning and adhesion of the sensor.***
- ***Applying an oximetry sensor incorrectly or leaving the sensor in place for too long may cause tissue damage, especially when monitoring neonates.***
- ***Check the sensor site frequently, and do not allow the sensor to remain on one site for too long. Refer to the instructions from the sensor manufacturer for more information.***
- ***Do not use a sensor with exposed optical components.***
- ***$SpO_2$ functional test fixtures can not be used to assess accuracy of a pulse oximeter sensor or monitor.***

**Caution:**

- **Use only patient sensors specified by Spacelabs Healthcare. If you use sensors other than those specified, it may degrade $SpO_2$ performance and could damage the monitor during defibrillation.**
- **Spacelabs Healthcare recommends the use of sensors repaired or remanufactured by the original manufacturer only.**
- **Never attach an $SpO_2$ sensor to a limb being monitored with a blood pressure cuff or a limb with restricted blood flow.**
- **A poorly applied sensor may give incorrect saturation values. The Sensorwatch signal-strength indicator is used to identify a poorly applied sensor or a poorly chosen site. Refer to Using the Sensorwatch Feature on page 17-12 for additional information.**
- **Choose a site with sufficient perfusion to ensure accurate oximetry values.**
- **An adapter cable is required between the sensor and the module. Do not discard the adapter cable when you have finished using a disposable oximetry sensor. Disconnect the sensor cable from the adapter cable before discarding the sensor.**

# Setting Up $SpO_2$ Monitoring

To display $SpO_2$ on the monitor, connect a compatible $SpO_2$ adapter cable to the module or telemetry transmitter. Note that module connectors are color-coded for ease of use. Attach the sensor to the patient before connecting the sensor cable to the adapter cable.

One of the two $SpO_2$ cable interconnection points normally involves a keyed latching mechanism.

***Note:***

- *For telemetry products, the latch is on the transmitter end of the adapter cable.*
- *For non-telemetry products, the latch (if present) is on the adapter cable end of the sensor cable.*

**To connect two cables with this type of keyed latching mechanism:**

1 Align one connector’s notch with the other connector’s keyed latch.

2 Push the connector with the notch into the connector with the keyed latch.

To disconnect these cables, release the latch and pull one cable straight out of the other.

**To connect an $SpO_2$ adapter cable to a module:**

1 Align the notch on the adapter cable's connector with the front of the module.

2 Push the cable straight into the connector.

To remove the cable, pull the cable straight out of the module's connector.

**To set up $SpO_2$ monitoring:**

- Connect the $SpO_2$ adapter cable to the module or to the patient-worn telemetry transmitter.
- Attach the sensor to the patient and connect the sensor cable to the $SpO_2$ adapter cable.
- Touch SPO2 (non-telemetry only).

**For telemetry monitoring:**

- Initiate ECG monitoring.
- Touch ECG.
- Touch CHANNEL FORMAT.
- Touch SPO2 / ON.

# Ensuring Accurate $SpO_2$ Monitoring

Each sensor requires site-specific application procedures. The quality of the patient's pulse oximetry measurements and pulse signals may be adversely affected by certain environmental factors, by oximetry sensor application errors, and by patient conditions. Any of these factors can interfere with the monitor's ability to detect and display measurements and may result in a loss-of-pulse condition. If the $SpO_2$ measurement does not seem reasonable, first check the patient's vital signs by alternate means and then check the pulse oximeter for proper operation.

Patients with anemia and/or significant concentrations of dysfunctional hemoglobins (such as carboxyhemoglobin, methemoglobin, and sulphemoglobin) may appear to have normal saturation values while actually being hypoxic. Further assessment, using means other than pulse oximetry, is recommended for such patients.

- For anemic patients, this condition occurs because patients have decreased arterial oxygen contents.
- For patients with dysfunctional hemoglobins (that are unable to carry oxygen), this condition occurs because less functional hemoglobin is available to carry oxygen.

**Caution:**

**Hemoglobin levels below 5 g/dl may prevent the monitor from providing $SpO_2$ values.**

**Other patient conditions that may result in inaccurate measurements or a loss-of-signal condition during operation include:**

- Low perfusion
- Dark pigment

- Prolonged and/or excessive patient movement
- An arterial occlusion (blocked artery) proximal to the sensor
- Venous pulsations
- Wrapping the sensor too tightly around the patient's digit or other extremity
- Placing the sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line
- Inflating a blood pressure cuff on the limb to which the sensor is attached

**External factors that may adversely affect the accuracy of oximetry readings include:**

- High ambient lighting
- High-frequency electrical noise, such as electrosurgical units and defibrillators
- The presence of intravascular dyes, such as indocyanine green or methylene blue, or externally applied coloring, such as nail polish or pigmented creams
- The patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia
- The patient is in cardiac arrest or is in shock

### Caution:

**Sources of high ambient light such as direct sunlight, surgical lights (especially those with a xenon light source), bilirubin lamps, fluorescent lights, and infrared heating lamps can interfere with an $SpO_2$ sensor's performance and result in inaccurate measurements. When using $SpO_2$ under such conditions, this interference can be reduced by covering the application site with an opaque material and by ensuring that the sensor is properly applied.**

**Taking the following actions may improve $SpO_2$ performance:**

- Select an application site with unrestricted blood flow.
- Do not select a site near potential electrical interference (e.g., electronic equipment, electrosurgical units, other power cords). If possible, remove these electrical noise sources from the area.
- If artificial nails or externally applied coloring agents such as nail polish are present, select another site or remove the polish/artificial nails.
- If necessary, wipe the sensor site for 20 to 30 seconds with a 70% isopropyl alcohol pad to improve perfusion.
- Apply the sensor correctly, ensuring that the LEDs and the photo detector are properly aligned directly opposite each other, preferably on a site that minimizes the distance between the emitter and photodetector. Periodically check to ensure that the sensor remains properly positioned on the patient.
- Do not restrict blood flow when securing a sensor with tape.
- If high ambient light is affecting measurements, ensure that the sensor is properly applied and then cover the application site with an opaque material such as a blanket or towel. Failure to do this may result in inaccurate measurements.
- Maintain a minimum signal level above the Sensorwatch bar.

**If patient movement presents a problem, one or more of the following may correct it:**

- Verify that the sensor is properly and securely applied.
- Move the sensor to a less active site; to reduce or eliminate motion artifact, the application site should remain as immobile as possible.

- Use an adhesive sensor that tolerates some patient motion.
- Use a new sensor with fresh adhesive backing.

# Display Detail

***Note:***

*For telemetry display information, refer to Display Detail on page 18-12 of the Digital Telemetry chapter.*

*Figure 17-1* and *Figure 17-2* illustrate typical $SpO_2$ displays. You can view oximetry values from any bedside or central monitor on a network.

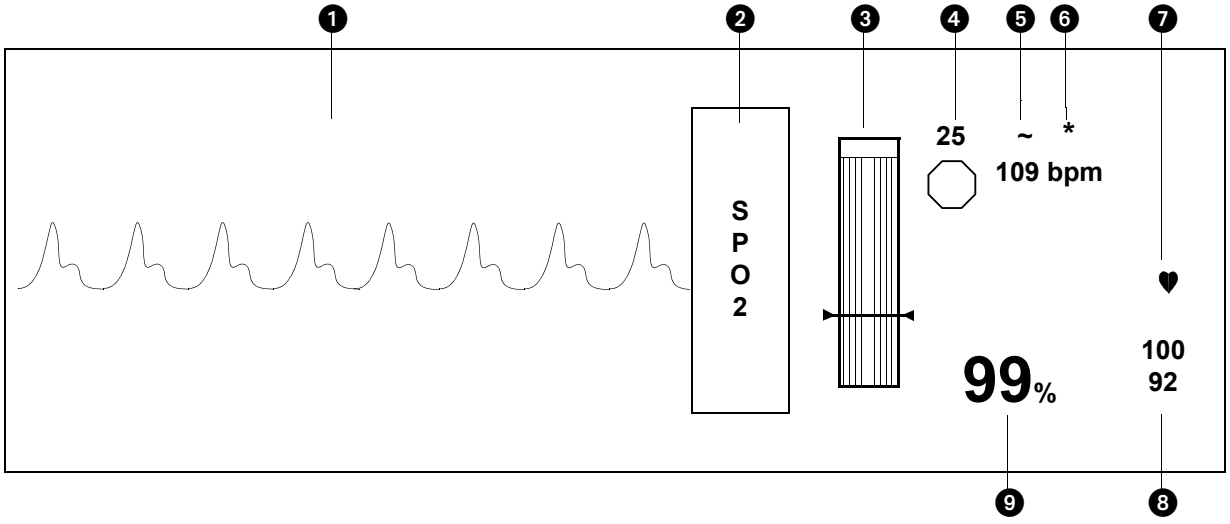



*Figure 17-1: Bedside monitor*

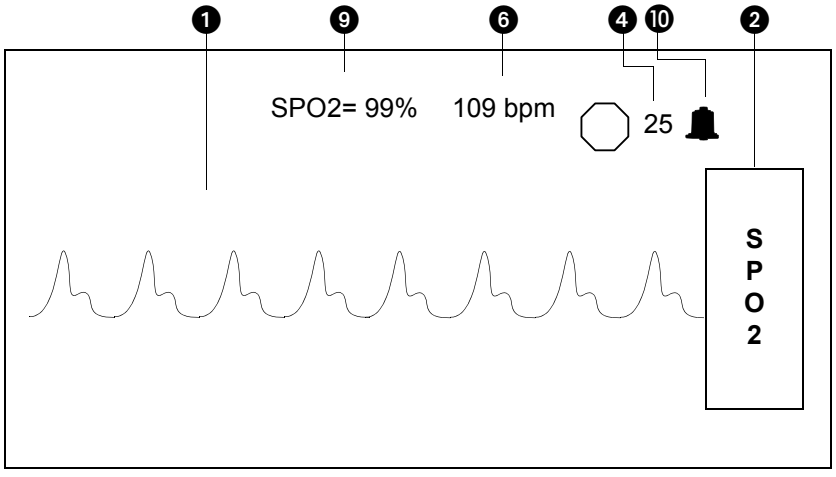



*Figure 17-2: Split-view central monitor*

1. Pulse plethysmographic waveform
2. SPO2 parameter key
3. Sensorwatch signal strength indicator

   The shaded area (waveform index, WFI) expands up proportionally to signal strength. The horizontal line indicates minimum signal level (Spacelabs $SpO_2$ technology only).

   No shading (lowest waveform index) corresponds to no detected signal strength or a faulty sensor.
4. SatSeconds indicator (Nellcor OxiMax only); number indicates the current setting
5. Motion indicator (Nellcor OxiMax only)
6. $SpO_2$ pulse rate (the asterisk flashes when pulse is detected—on bedside monitors only)
7. NO PULSE alarm indicator; indicates if the NO PULSE alarm is enabled (Nellcor OxiMax only)
8. High and low $SpO_2$ alarm limits (on bedside monitor only)
9. Current $SpO_2$ value (percent)
10. The bell indicates that alarms are enabled (on split-view central monitor only)

# Using the Sensorwatch Feature

The Sensorwatch feature provides a graphical presentation of the amplitude of the signal received from the sensor. It can be used to determine the best sensor site and application.

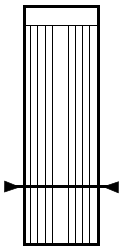


*Figure 17-3: Sensorwatch bar*

Changes in the bar's shaded level signify changes in the patient's perfusion or changes in the application of the sensor. The horizontal line in the bottom fourth of the bar is used in Spacelabs Healthcare $SpO_2$ technology only and represents the minimum signal level that results in accurate saturation values.

When the shading is just below this line, the message *LOW SIGNAL STRENGTH - Reposition or replace sensor* appears.

- Reposition the sensor to a different site to provide better perfusion.
- Reposition the sensor to provide better contact with the skin. Make sure the LEDs and photo detector are properly aligned.
- Replace a defective sensor.
- Wait for the patient to warm up and for the patient's perfusion to increase.

# NO PULSE Alarm Indicator (Nellcor OxiMax Technology)

When using Nellcor OxiMax technology, a NO PULSE alarm (a small heart) displays above the $SpO_2$ alarm limits in the full-width display zone whenever the NO PULSE alarm is enabled. If a persistent loss-of-pulse condition is detected, a *NO PULSE DETECTED* message displays in the waveform zone, and the NO PULSE alarm indicator will flash. When the NO PULSE alarm condition is indicated, always check the patient.

**If the patient is stable, then check or try the following:**

- Check the sensor site to determine if the sensor is applied too tightly to the patient's digit. Reapply the sensor as necessary.
- Check if the sensor is on an extremity with a blood pressure cuff, an arterial catheter, or an intravascular (IV) line.
- Cover the site with an opaque blanket or towel if excessive ambient light, such as a bedside lamp or direct sunlight, is interfering with the measurements.
- Remove all sources of excessive electromagnetic interference that may prevent the monitor from tracking the pulse.
- Ensure that the sensor being used is appropriate for the patient being monitored.
- Check if excessive patient motion is preventing the monitor from tracking the pulse. Keep the patient still, if possible. Verify that the sensor is securely applied and replace it if necessary. If patient motion is an ongoing issue, use an alternate sensor site or a different sensor model.

## SatSeconds Display (Nellcor OxiMax technology)

The SatSeconds indicator displays to the right of the Sensorwatch bar if the SatSeconds limit is turned ON. When the SatSeconds algorithm detects an $SpO_2$ value outside the alarm limit, the SatSeconds indicator "fills" clockwise. When the indicator is completely filled (the SatSeconds setting is reached), an $SpO_2$ high or low limit alarm begins. When the $SpO_2$ value returns to within the set limits, this indicator "empties" counter-clockwise.

# Enabling and Adjusting Alarms

## Spacelabs Healthcare and Masimo SET Technology

Pulse oximetry alarm limits and delays are set internally based upon defined default values. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To enable and adjust $SpO_2$ alarms (non-telemetry):**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch HIGH=, LOW=, ALM DELAY (if present), or MSG ALARM DELAY (if present).
- Use the arrow keys to adjust.

**To enable and adjust $SpO_2$ alarms (telemetry):**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch SPO2 ALARM LIMITS.
- Select SPO2 ALM / ON.
- Select HI=, LO=, ALM DELAY, or MSG ALARM DELAY (if present).
- Use the arrow keys to adjust.

## Additional Information for Telemetry Products

When $SpO_2$ alarms are enabled, a bell symbol appears immediately following the measured $SpO_2$ saturation percentage (%).

## Nellcor OxiMax Technology

With traditional alarm management, upper and lower alarm limits are set for monitoring oxygen saturation. If a patient's $SpO_2$ level fluctuates near an alarm limit, frequent short $SpO_2$ alarms can occur.

If the Nellcor SatSeconds feature is enabled, then the alarm limit threshold must be continuously violated for a specified number of SatSeconds before an alarm occurs.

When the $SpO_2$ level violates a limit threshold, SatSeconds will begin to be counted, and the SatSeconds indicator begins to fill clockwise. Each second the number of percentage points that the saturation value is in violation of the threshold is added to the SatSeconds count. When the SatSeconds count meets or exceeds the SatSeconds setting, the SatSeconds indicator is completely filled, and the alarm sounds.

When the saturation value is no longer in violation of the limit, the alarm will stop and the SatSeconds indicator begins to empty. If the patient's oxygen saturation violates the limit again, then the SatSeconds indicator begins to fill again. Another alarm sounds if the indicator becomes completely filled.

***Note:***

*If an alarm threshold is crossed three or more times in a 60-second period, an alarm is triggered, even if the SatSeconds limit has not been attained.*

**To enable and adjust $SpO_2$ alarms (Nellcor):**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch HIGH=, LOW=.
- Use the arrow keys to adjust.

## SatSeconds Calculation Example

*Figure 17-4* illustrates a low $SpO_2$ alarm limit setting of 90 and a SatSeconds setting of 50. The $SpO_2$ level starts above 90, falls to 88 (2 points) for 2 seconds, then falls to 86 for 3 seconds, and then falls to 84 for 6 seconds. The calculation of the resulting SatSeconds value (52) is shown below. This calculation delays the start of the low $SpO_2$ alarm until 50 SatSeconds is exceeded (approximately 10.9 seconds).

2 x 2 = 4

4 x 3 = 12

6 x 6 = 36

Total SatSeconds = 52

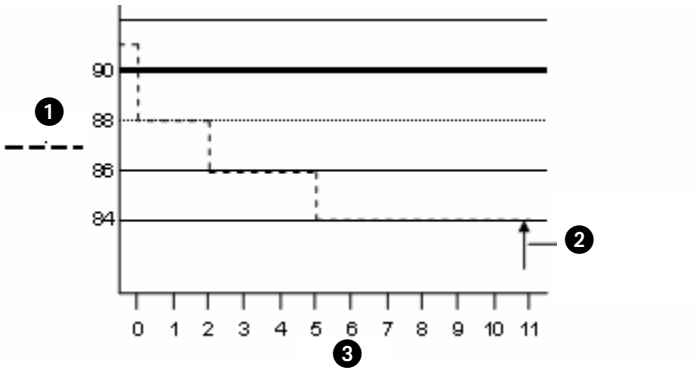



*Figure 17-4: Alarm delay time with SatSeconds*

1. % $SpO_2$
2. 50 SatSeconds alarm point reached
3. Seconds

Saturation levels may fluctuate rapidly rather than remain steady. The $SpO_2$ level may fluctuate above and below the alarm limit, re-entering the non-alarm range several times. During such fluctuations, the monitor integrates the number of $SpO_2$ points, both positive and negative, until either the SatSeconds limit is reached (when a new alarm begins) or the $SpO_2$ level returns to a normal range and remains there.

**To turn ON Nellcor SatSeconds functionality:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch SatSecs.
- Use the arrow keys to adjust the SatSeconds limit.

**To enable the NOPULSE ALARM:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch NO PULSE / ON.

**To disable the NOPULSE ALARM:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch NO PULSE / OFF.

# Data Averaging

The data averaging feature smooths the oximetry saturation value by averaging patient input values over several seconds. However, pulse oximeters based on Spacelabs Healthcare or Masimo SET technology and those based on Nellcor OxiMax technology perform data averaging differently.

## Data Averaging with Spacelabs Healthcare or Masimo SET Technology

The data averaging interval is manually selected. For non-telemetry products, this is performed using the **Averaging** menu. For telemetry products, refer to the *90341, 90343, 90347, 90478, 90479, 91341 Ultraview Digital Telemetry Service Manual* (P/N 070-0744-xx), located on CD-ROM P/N 084-0700-xx for setting the data averaging interval.

**To specify a data averaging time:**

- Touch SPO2.
- Touch SETUP.
- Touch AVERAGING.
- Use the arrow keys to adjust.

## Data Averaging with Nellcor OxiMax technology

Nellcor data averaging is controlled by the RESPONSE MODE setting.

**To specify a RESPONSE TIME setting:**

- Touch SPO2.
- Touch SETUP.
- TOUCH RESPONSE MODE.
- Select either NORMAL or FAST.

When RESPONSE MODE is set to NORMAL, the averaging interval is six to seven seconds. When the RESPONSE MODE is set to FAST, the averaging interval is two to four seconds. The averaging interval can be automatically extended by the OxiMax algorithm during challenging measurement conditions. Such conditions include low perfusion, motion, external interference, or any combination of these conditions.

# Sensitivity and FAST SAT (Masimo SET Technology)

With Masimo SET technology, selections for SENSITIVITY and whether to use Masimo FAST SAT algorithm are available.

## Sensitivity Settings

Choices for SENSITIVITY are NORMAL, MAXIMUM, and APOD (Adaptive Probe Off Detection). The three sensitivity settings allow the clinician to adapt to the patient's situation.

The APOD sensitivity setting uses processing algorithms to analyze the incoming signal. This setting is used to protect against erroneous pulse rate and $SpO_2$ readings that can occur when a sensor becomes detached from the patient.

The APOD setting is the least effective setting for measuring $SpO_2$ on patients with low perfusion.

The NORMAL sensitivity setting recommended for the majority of patients. This setting provides a combination of sensitivity and detached sensor detection.

MAXIMUM sensitivity is used in instances where $SpO_2$ measurements are the most difficult, and when the signal is the weakest (such as with the sickest patients). This setting is recommended during procedures and when clinician and patient contact is continuous.

If low perfusion and movement inhibits Masimo SET technology from determining a reading, change the sensitivity setting from APOD to MAXIMUM or NORMAL.

**To select Masimo SENSITIVITY:**

- Touch SPO2.
- Touch SETUP.
- Touch SENSITIVY.
- Select the sensitivity (NORMAL, MAXIMUM, APOD).

## FAST SAT Settings

Selecting FAST SAT/ON enables that algorithm. Selecting FAST SAT/OFF disables the Fast SAT algorithm.

FAST SAT is automatically enabled whenever averaging is set to 2-4 or 4-6 seconds. However, the key will not indicate that the FAST SAT algorithm is ON when these averaging settings are used.

**To enable and disable the Masimo FAST SAT algorithm:**

- Touch SPO2.
- Touch SETUP.
- Touch FAST SAT/ON or FAST SAT/OFF.

# Using $SpO_2$ with Intra-Aortic Balloon Pumps

Enable the intra-aortic balloon pump (IABP) feature if an IABP is in use. This selection is only available for Spacelabs Healthcare $SpO_2$ technology. With the IABP feature enabled, the $SpO_2$ software differentiates between true arterial pulsations and those produced by the IABP by excluding the IABP-generated pulsations from the calculation for $SpO_2$. The IABP feature can also be useful with patients experiencing irregular heart rhythms, by permitting the software to reject irregular pulses and provide a more accurate $SpO_2$ measurement.

**To use $SpO_2$ with a balloon pump (non-telemetry):**

- Touch SPO2.
- Touch IABP YES.

***Note:***

- *When the IABP feature is enabled, the pulse rate obtained from $SpO_2$ may not match the heart rate obtained from ECG.*
- *In cases of excessive patient motion or artifact, the accuracy of the $SpO_2$ measurement may be compromised when the IABP feature is enabled.*
- *When the IABP operation is selected for telemetry monitoring, the SPO2 status key in the **ECG Channel Format** menu indicates IABP. The Ultraview Digital Telemetry Service Manual (P/N 070-0744-xx), which is located on CD-ROM P/N 084-0700-xx describes how to configure the telemetry transmitter for use with an IABP.*

# Adjusting Tone Volume

With the pulse tone feature turned ON, you can adjust the tone volume. The pitch varies according to the $SpO_2$ value. The higher the oxygen saturation, the higher the pitch.

**To adjust tone volume (non-telemetry only):**

- Touch SPO2.
- Touch SETUP.
- Touch TONE.
- Touch TONE / ON.
- Touch VOLUME ↑ or VOLUME ↓ to adjust.

# Adjusting Waveform Size

You can adjust the waveform size for clarity. Changing the height of the displayed waveform does not affect the signal gain and is not related to the pulse amplitude.

**To modify the waveform display (non-telemetry only):**

- Touch SPO2.
- Touch SETUP.
- Verify WAVEFORM is ON.
- Touch SIZE.
- Touch SIZE↑ or SIZE↓ to adjust.

# Viewing Pulse Rate

## Non-Telemetry

Use the Pulse Rate feature to obtain and view a pulse rate derived from the saturation data. The pulse rate is displayed within the range of 30 to 250 beats per minute, ±3 beats per minute. For Nellcor OxiMax technology, the range is 20 to 300 beats per minute, ±3 beats per minute.

**To enable the pulse rate display (non-telemetry):**

- Touch SPO2.
- Touch PULSE RATE / ON or OFF.

## Telemetry

For telemetry monitoring, the pulse rate for display is obtained directly from the acquired ECG leads or an alternate rate source. $SpO_2$ can be used as the alternate source if the multiparameter telemetry transmitter is set for continuous measurement. $SpO_2$ cannot be used as the alternate source when $SpO_2$ is set for episodic measurement (bedside monitors only). Refer to *ECG* on page 10-5 for additional information.

# Suspending/Resuming $SpO_2$ Processing

Touch YES on the **Suspend Processing** menu to suspend analysis and to display the $SpO_2$ data. Touch NO to return to the **$SpO_2$** menu without affecting processing.

**To suspend $SpO_2$ processing:**

- Touch SPO2.
- Touch SUSPEND PROCESSING.
- Touch YES.

**To resume $SpO_2$ processing:**

- Touch SPO2.
- Touch RESUME PROCESSING.
- Touch YES.

**When you suspend $SpO_2$ processing:**

- The message *SPO2 PROCESSING SUSPENDED* appears in the $SpO_2$ waveform zone.
- Question marks (**???**) replace the $SpO_2$ and pulse rate values.
- The message *SPO2 ALM OFF* replaces the alarm limits.
- The keys in the **SPO2 Alarm Limits** menu are disabled.
- The SUSPEND PROCESSING key changes to RESUME PROCESSING.

# Suspend on NIBP

Suspend on NIBP is used when the NIBP cuff and the $SpO_2$ sensor are on the same limb. When the SUSPEND ON NIBP key is set to YES, $SpO_2$ processing is suspended during NIBP measurements. By default, the SUSPEND ON NIBP key is set to OFF.

$SpO_2$ suspension begins when the NIBP cuff is fully inflated. When $SpO_2$ processing is suspended, the message PROCESSING SUSPENDED is displayed in the $SpO_2$ waveform zone, the waveform is removed from the screen, and alarms are terminated. $SpO_2$ suspension ends when the NIBP cuff is deflated. Normal $SpO_2$ processing is then resumed.

While $SpO_2$ processing is suspended, the RESUME PROCESSING key is enabled. You can touch RESUME PROCESSING at any time to manually override the suspended state and return $SpO_2$ to normal processing. The next time the cuff is inflated, $SpO_2$ will be suspended automatically (assuming that the SUSPEND ON NIBP key still is set to YES).

If the SUSPEND ON NIBP key is toggled from YES to NO while the NIBP cuff is inflated, $SpO_2$ processing will return to the normal processing state from the suspended processing state.

**To suspend $SpO_2$ processing during NIBP measurement:**

- Touch SPO2.
- Touch SUSPEND ON NIBP / YES.

# Printing $SpO_2$ Waveforms

You can print $SpO_2$ waveforms and values. Refer to *Printing* on page 9-5 for additional information.

***Note:***

*This feature is not supported in telemetry products.*

**To print $SpO_2$ waveforms:**

- Touch RECORD.
- Touch the flashing SPO2 parameter key.

# Status Messages

**Caution:**

**Status messages indicate problems or conditions that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

When a status message appears, the saturation value and pulse rate immediately change to **???**. An alarm may occur if your module is configured to do so. Depending on the configuration and option purchased, this alarm may not occur until after the message alarm delay time has elapsed.

Telemetry products use different text for $SpO_2$ status messages than non-telemetry products. Refer to *Table 1* for interpretations of the telemetry messages.

**Telemetry products also display status messages within the ECG display zone, therefore, the following ECG alarm messages take priority over other $SpO_2$ messages.**

- *LEADS OFF*
- *NOISY SIGNAL*
- *ECG ALARMS SUSPENDED*

*Table 1: Telemetry Message Equivalents*

| $SpO_2$ Message | Equivalent Telemetry $SpO_2$ Message |
|---|---|
| *ADAPTER DISCONNECTED – Check connection at module* | *SPO2 SENSOR DISCONNECTED* |
| *FAULTY SENSOR – Replace sensor* | *SPO2 FAULTY SENSOR* |
| *SENSOR DISCONNECTED – Check connection at adapter cable* | *SPO2 SENSOR DISCONNECTED* |
| *SENSOR OFF PATIENT – Check connection at patient* | *SPO2 SENSOR OFF PATIENT* |
| *INSUFFICIENT SIGNAL – Reposition or replace sensor* | *SPO2 INSUFFICIENT SIGNAL* |
| *AMBIENT LIGHT INTERFERENCE – Cover sensor area* | *SPO2 AMBIENT LIGHT INTF.* |
| *NOISY SIGNAL* | *SPO2 NOISY SIGNAL* |
| *LOW SIGNAL STRENGTH – Reposition or replace sensor* | *SPO2 INSUFFICIENT SIGNAL* |

### ADAPTER DISCONNECTED — Check connection at module

- The module does not detect an adapter cable connected to the front panel. Check proper adapter cable connection.
- If the message persists and the adapter cable is secure, then replace the adapter cable.
- If the channel is removed from the display, then the alarm stops after approximately 10 seconds.
- On remote view, there may be no audible alarm on the remote monitor before the channel is removed from the display.

### SENSOR DISCONNECTED — Check connection at adapter cable

This message and alarm indicate that the sensor is either disconnected or the wiring is faulty.

- Check for proper sensor connection to the adapter cable.
- If the message persists, replace the sensor and/or the adapter cable.

### SENSOR OFF PATIENT — Check connection at patient

- The module does not detect a valid sensor input signal. Check the patient for proper sensor placement.
- The tissue between the LED and photodiode is too transmissive. If the sensor placement seems correct and the message persists, try a sensor site with a thicker tissue bed.

***Note:***

*This message is not available with all $SpO_2$ sensors.*

### INSUFFICIENT SIGNAL — Reposition or replace sensor

- Insufficient signal for proper operation, indicated by a low deflection on the Sensorwatch signal strength bar.
- Poor sensor application or site. Correctly re-apply or reposition to a better perfused site, or massage the site.
- If the message persists, then replace the sensor.

### AMBIENT LIGHT INTERFERENCE — Cover sensor area

- The sensor is receiving external light interference from a bright light source near the sensor. Shield the sensor from the external light source.
- The sensor photodiode and LED are misaligned on flexible sensors, allowing light to enter. Realign the sensor photodiode with the LED.
- If the message persists, then replace the sensor.

### NOISY SIGNAL

- The sensor signal is disturbed by motion or other interference. Eliminate sensor movement.
- Power cords or other electrically noisy devices are too close to the sensor. Move the noisy device or move the sensor to another site.
- If the message persists, then replace the sensor.

### LOW SIGNAL STRENGTH — Reposition or replace sensor

When this message appears, the saturation and pulse rate continue to display. However, the Sensorwatch bar flashes as an indication of a possible error condition.

- Insufficient blood flow between the sensor light emitter and detector. Move the sensor to an area of higher perfusion.
- Poor sensor application. Reposition to place active components closer to the skin or locate to a better perfused site.
- The sensor site is below the blood pressure cuff. Move to another site.
- If the message persists, then replace the sensor.

### HARDWARE INCOMPATIBILITY — Contact service

The hardware configuration in your module is not compatible with the programmed software options.

- Contact your Spacelabs Healthcare Field Service Engineer.

### FAULTY SENSOR — Replace sensor

- The LED or photodiode (or both) may have failed.
- Ensure the sensor is properly connected, disconnect and then reconnect the sensor.
- If the error occurs again, replace the sensor and/or sensor adapter cable.
- If replacing the sensor and/or cable does not correct the problem, contact your Spacelabs Healthcare Field Service Engineer.

## Status Messages — Nellcor OxiMax Technology

### FAULTY SENSOR — OxiMax Sensors Only

This message displays if a sensor other than a Nellcor OxiMax sensor is used. It may also appear if a defective OxiMax sensor is used.

- To clear this message, apply a functional Nellcor OxiMax sensor. Note that this message does not clear when the faulty sensor is removed, but only when a valid sensor is applied.

### OXIMETER FAILURE — Error XXX

*XXX* is a numeric error code. This message is displayed if the oximeter has experienced a fatal error and is attempting to restart. If the oximeter is successfully restarted, the message clears and normal operation is restored.

If the oximeter cannot be restarted, then *Contact Service* will be appended to the end of the message. If the oximeter fails at power-ON, then the SPO2 channel appears on the display with the error message.

- If the *Contact Service* portion of the message is not displayed, the system is attempting to restart the oximeter. Wait one minute to see if the oximeter restarts.
- When the *Contact Service* portion of the message is displayed, remove the module and reinsert. This may restore functionality.
- If reinserting the module does not clear the error, contact your Spacelabs Healthcare Field Service Engineer.

## NO PULSE DETECTED

**This message is displayed under the following circumstances:**

- the NO PULSE alarm is enabled;
- the sensor appears to be connected and on the patient;
- the oximeter cannot find a pulse signal.

**When this message displays:**

- Follow the instructions under *NO PULSE Alarm Indicator (Nellcor OxiMax Technology)* on page 17-13 to restore the pulse signal.

## INSUFFICIENT SIGNAL

This message displays if the signal received by is inadequate to process $SpO_2$. The sensor may be applied incorrectly, or there may be signal interference. When an *INSUFFICIENT SIGNAL* message displays, an additional message will display on the line below and will identify possible causes and solutions.

**Possible Causes**

Sensor off

Weak pulse

Weak signal

Motion interference

Excess infrared light

Electrical or optical interference

High pulse amplitude

**Suggested Solutions**

Alternate site

Cover sensor site

Ear or forehead sensor

Nasal or ear sensor

OxiMax adhesive sensor

Secure cable

Headband

Warm site

Bandage assembly

Nail polish

Sensor too tight

Reposition sensor

Isolate interference source

Clean sensor site

# Status Messages — Masimo SET Technology

### FAULTY OXIMETER — Contact Service

If the module's Masimo SET technology fails, a *FAULTY OXIMETER* message displays. If the oximeter cannot be restarted, then *Contact Service* will be appended to the end of the message.

- If the *Contact Service* portion of the message is not displayed, the system is attempting to restart the oximeter. Wait one minute to see if the oximeter restarts.
- When the *Contact Service* portion of the message is displayed, remove the module and then reinsert. This may restore functionality.
- If reinserting the module does not clear the error, contact your Spacelabs Healthcare Field Service Engineer.

### LOW PERFUSION

This message displays if a low perfusion condition is detected.

### LOW SIGNAL STRENGTH — Reposition or replace sensor

This message displays if there is an insufficient signal. If a saturation value does not display with this message, then an alarm occurs.

### INTERFERENCE DETECTED — Check sensor and cables

This message occurs when interference other than light interference is detected.

# Sensors

For $SpO_2$ sensor compatibility, refer to the following information.

## Spacelabs Healthcare $SpO_2$ Sensors

Adapter cable 700-0030-00 is required for the 90496 and 91496 modules; adapter cable P/N 700-0014-00 is required for 90343-05 transmitters. Please refer to the *Spacelabs Healthcare Supplies & Accessories Catalog* (P/N 084-1201-xx) for compatible sensors and adapter cables.

## Nellcor OxiMax $SpO_2$ (91496-N) Sensor Compatibility

Adapter cable P/N 700-0792-00 is required. Please refer to the *Spacelabs Healthcare Supplies & Accessories Catalog* (P/N 084-1201-xx). The following sensor lines are compatible with 91496-N:

*Table 2: Nellcor sensors compatible with 91496-N*

| OxiMax Sensors (single-patient use) | OxiCliq Sensors (single-patient use) | Reusable Sensors |
|---|---|---|
| MAX-A, MAX-AL | OxiCliq A | D-YS |
| MAX-N | OxiCliq P | D-YS, D-YSE |
| MAX-P | OxiCliq N | D-YS, D-YSPD |
| MAX-I | OxiCliq I | DS-100A |
| MAX-FAST | | OXI-A/N |
| MAX-R | | OXI-P/I |

## Masimo SET $SpO_2$ (91496-M) Sensor Compatibility

Adapter cable P/N 700-0789-00 is required. Please refer to the *Spacelabs Healthcare Supplies & Accessories Catalog* (P/N 084-1201-xx). The entire family of LNOP sensors is supported.

## Additional Information

For additional information about biocompatibility or sensor disposal, refer to the manufacturer's instructions enclosed with each sensor.

# $SpO_2$ Alarm Delays

*Table 3: $SpO_2$ Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| **Spacelabs Healthcare** | | |
| Sat Low | 50 to 99% | • Less than (15 seconds + user selected alarm delay)<br>• Alarm delay is user selected from 0 to 30 seconds in 5 second increments. |
| Sat High | 51 to 100% | • Less than (20 seconds + user selected alarm delay)<br>• Alarm delay is user selected from 0 to 30 seconds in 5 second increments. |
| **Masimo SET** | | |
| Sat Low | 50 to 99% | • Less than (17 seconds + user selected alarm delay)<br>• Alarm delay is user selected from 0 to 10 seconds in 5 second increments. |
| Sat High | 51 to 100% | • Less than (17 seconds + user selected alarm delay)<br>• Alarm delay is user selected from 0 to 10 seconds in 5 second increments. |
| **Nellcor Oximax** | | |
| Sat Low | 50 to 99% | • Less than (10 seconds + user selected Smart Sat delay)<br>• Smart Sat delay is user selected at 0, 25, 50 or 100 and is a function of how far the measured saturation is above/ below the threshold. |
| Sat High | 51 to 100% | • Less than (10 seconds + user selected Smart Sat delay )<br>• Smart Sat delay is user selected at 0, 25, 50 or 100 and is a function of how far the measured saturation is above/ below the threshold. |
| No-Pulse | ON/OFF | • Less than 10 seconds |

# $SpO_2$ Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No $SpO_2$ parameter key is displayed** | ■ Module is not inserted correctly. | ■ Remove and reinsert the module. |
| | ■ Adapter cable is improperly connected to the module. | ■ Correctly connect the adapter cable. |
| | ■ Sensor is not connected to the adapter cable. | ■ Correctly connect the sensor. |
| | ■ $SpO_2$ is not enabled at the 90343 transmitter. | ■ Contact your biomed or a qualified field service engineer to check the DIP switches 1 and 2 on the transmitter. |
| | ■ $SpO_2$ is not enabled at the 90478 receiver. | ■ Enable multiparameter telemetry in the Module Configuration Manager or enable the $SpO_2$ display in the **Channel Format** menu. |
| **$SpO_2$ value displays as ???** | ■ Sensor is not connected to the patient. | ■ Reattach the sensor. |
| | ■ There is excessive patient motion. | ■ Request patient to remain still while reading is in progress. |
| | ■ Module is in the initialization phase (the first 15 seconds after sensor application). | ■ Wait until the initialization is complete. |
| | ■ Adapter cable is improperly connected to the module. | ■ Correctly connect the adapter cable. |
| | ■ Sensor is not connected to the adapter cable. | ■ Correctly connect the sensor. |
| | ■ Telemetry low battery indicator is constantly illuminated. | ■ Contact your biomed or a qualified field service engineer. |

## $SpO_2$

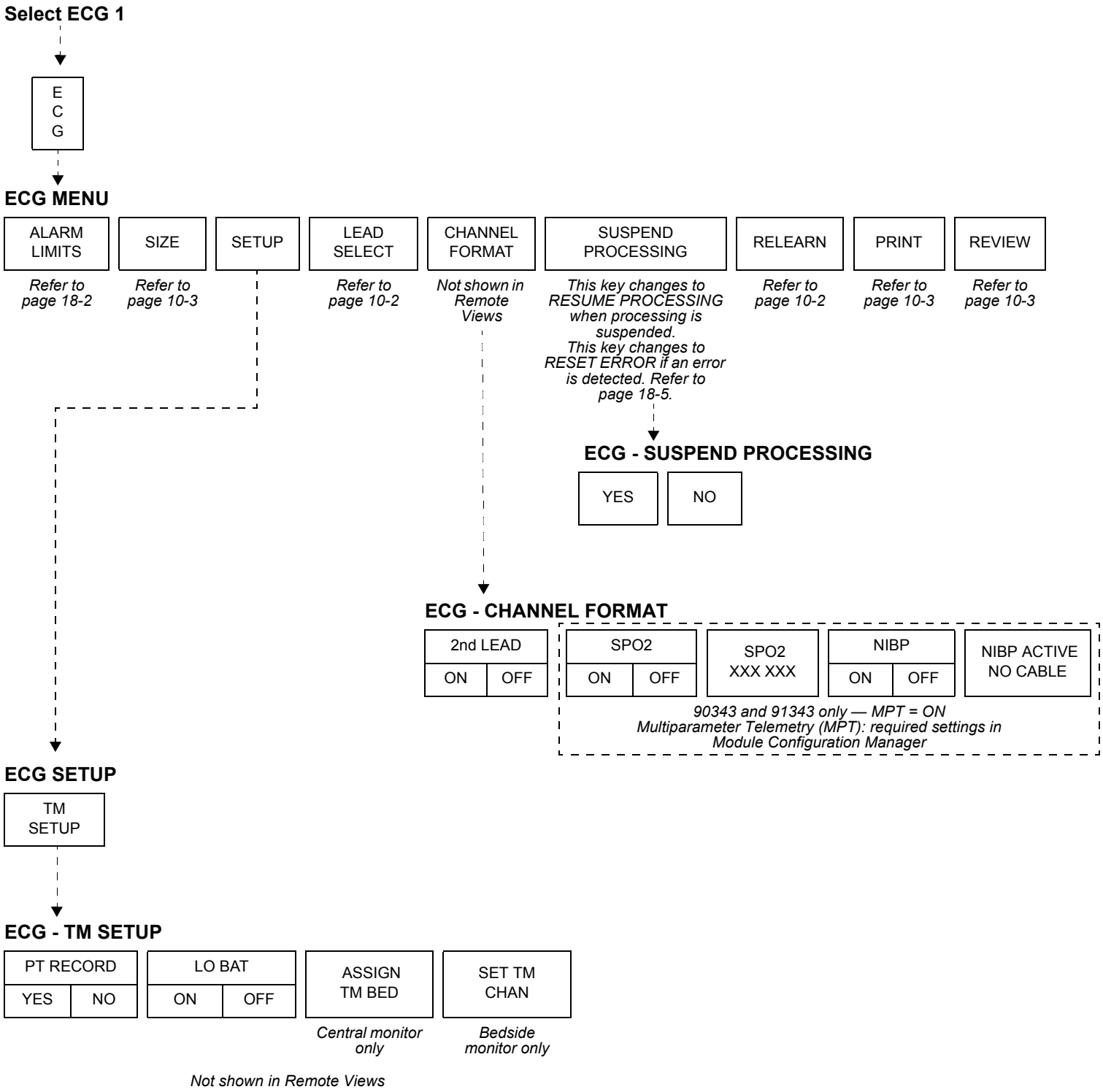
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Low signal strength** | ■ Sensor placement is not optimum. | ■ Move the sensor to a site which has better perfusion.<br>■ Align the LED with the sensor photo detector. |
| | ■ Sensor is placed below the blood pressure cuff. | ■ Move the sensor to an alternate limb. |
| **Intermittent or complete failure to operate** | ■ Module error. | ■ Contact your biomed or a qualified field service engineer. |
| **Factors causing significant variances in sensor accuracy** | ■ Presence of dysfunctional hemoglobins (COHb, MetHb). | ■ Follow hospital procedure for determining oxygenation in these patients. |
| | ■ Presence of intravascular dyes (indocyamine green, methylene blue) in the blood stream. | ■ Follow hospital procedure for determining oxygenation in these patients. |
| | ■ High ambient light level. | ■ Reduce light levels near the patient. |
| | ■ Electrosurgical interference. | ■ Follow hospital procedure for determining oxygenation in these patients. |
| | ■ Patient is significantly anemic (Hb less than 5 g/dl) or has received large amounts of IV solutions. | ■ Follow hospital procedure for determining oxygenation in these patients. |
| **No $SpO_2$ alarms are displayed (telemetry only)** | ■ ECG “Leads Off” condition exists. | ■ Re-attach ECG lead wires to the patient and resume ECG monitoring. |
| | ■ Higher priority alarm condition is present. | ■ Clear the current alarm condition and/or re-prioritize $SpO_2$ alarms in the Module Configuration Manager.<br>■ When $SpO_2$ alarms are ON, all $SpO_2$ alarm conditions cause the parameter value to blink according to the alarm priority set using the Module Configuration Manager. |

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **FAULTY SENSOR Replace Sensor (OxiMax sensors only)** | ■ A faulty or incompatible sensor is connected to the adapter cable.<br>■ Sensor has failed. | ■ To clear the message, connect a known good Nellcor OxiMax sensor to the adapter cable, or unplug the module. |

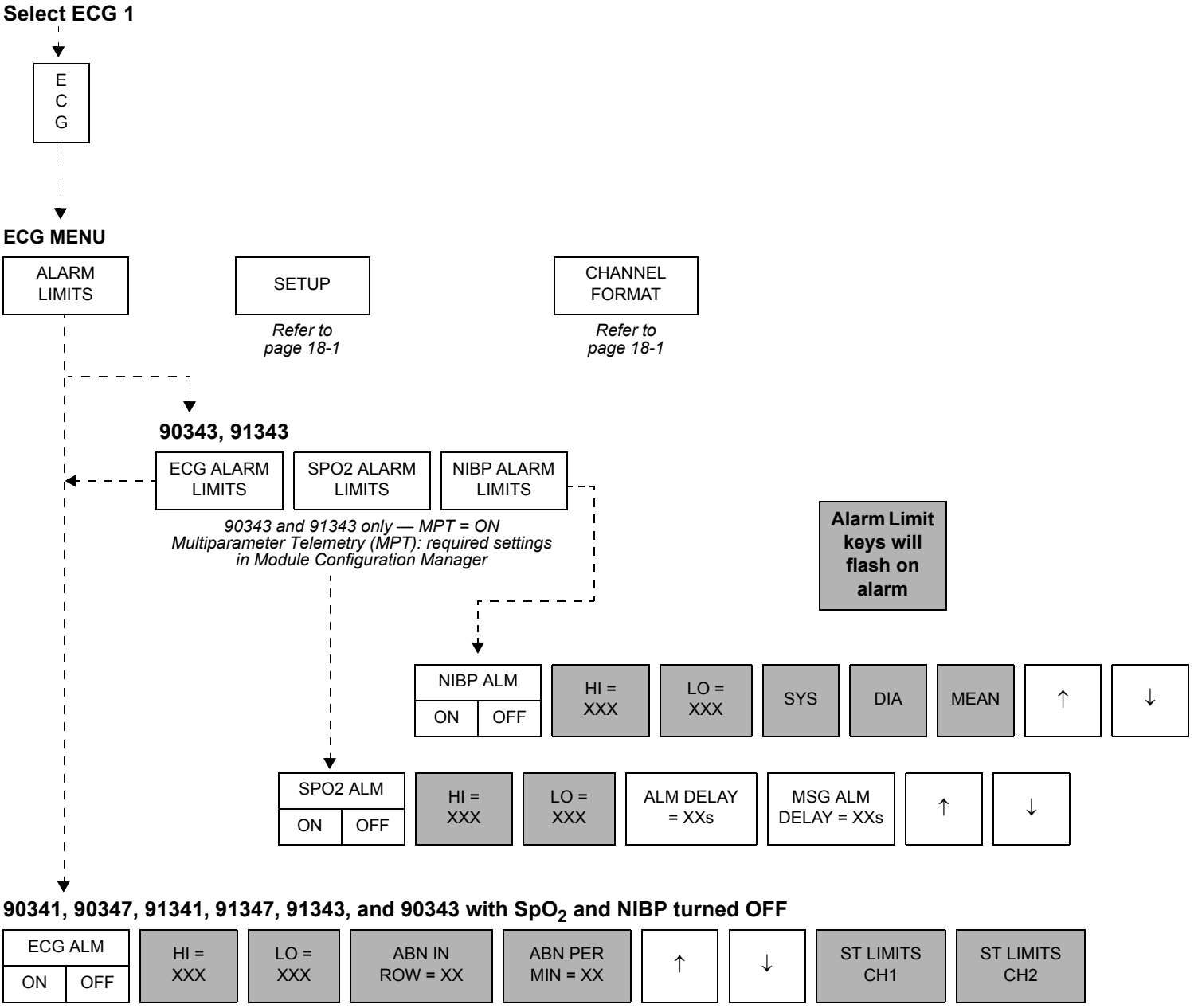
# Digital Telemetry

## Directory of Keys

### ECG



# ECG (continued)



# Digital Telemetry

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Warnings and Cautions . . . 4
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## Overview

The digital telemetry receiver module (90478), when used in conjunction with a Spacelabs Healthcare patient-worn telemetry transmitter, a Spacelabs Healthcare monitor, telemetry receiver module housing (90479-B/C), and a diversity antenna system, provides continuous monitoring of electrocardiographic signals. These electrocardiographic signals detect abnormal cardiac rhythms, including asystole, ventricular fibrillation, and ventricular runs.

When used with the multiparameter digital telemetry transmitter (90343/91343) and/or the Ambulatory Blood Pressure (ABP) monitor (90217), monitoring of electrocardiographic signals is enhanced by the availability of continuous or episodic $SpO_2$ measurements and/or episodic noninvasive blood pressure (NIBP) measurements.

ECG monitoring in telemetry is identical to hardwired ECG monitoring (refer to *ECG Setup* on page 10-6). For more information on $SpO_2$ and NIBP monitoring, refer to *Setting Up SpO2 Monitoring* on page 17-8 and *Multiparameter Telemetry (NIBP)* on page 18-18.

***Note:***

- *Spacelabs Healthcare's telemetry equipment complies with Part 15 and Part 95 of the FCC Rules and with RSS-210 of Industry Canada and with requirements of other national spectrum management authorities.*
  - *Repeated here are operational cautions for biomedical telemetry from the FCC Rules (47CFR15.242(f)): "Biomedical telemetry devices must not cause harmful interference to licensed TV broadcast stations or to other authorized radio services, such as operations on the broadcast frequencies under subpart G and H of part 74 of this chapter, land mobile stations operating under part 90 of this chapter in the 470-512 MHz band, and radio astronomy operation in the 608-614 MHz band. (See section 15.5). If harmful interference occurs, the interference must either be corrected or the device must immediately cease operation on the occupied frequency. Further, the operator of the biomedical telemetry device must accept whatever level of interference is received from other radio operations. The operator, i.e., the health care facility, is responsible for resolving any interference that occurs subsequent to the installation of these devices."*

- *Telemetry devices are only permitted for installation in hospitals and health care facilities. Devices shall not be operated in mobile vehicles (even ambulances and other vehicles associated with health care facilities). The installer/user of a model 9034x-05 transmitter (608 to 614 MHz) device shall ensure that it is at least 80 km from the Penticton radio astronomy station (British Columbia latitude: 49° 19' 12" N, longitude: 118° 59' 56" W). For medical telemetry systems not meeting this 80 km separation (e.g. the Okanagan Valley, British Columbia) the installer/user must coordinate with and obtain the written concurrence of the Director of the Penticton radio astronomy station before the equipment can be installed or operated. The Penticton contact is Tel: 250-493-2277/fax: 250-493-7767. (In case of difficulty, the Manager, Radio Equipment Standards, Industry Canada, may also be contacted.)*

- *Medical telemetry equipment is only for installation and use in hospitals and health care facilities. It is not permitted for use in vehicles that operate outside of the medical facility premises. The user of this equipment is not authorized to make any changes or alterations that could compromise the national certifications.*
- *Operation of telemetry equipment in the 608 to 614 MHz, part of the Wireless Medical Telemetry Service (WMTS), and in authorized spectrum of each country, may be geographically restricted by government regulation. Operation of this equipment in all U.S. WMTS bands requires coordination and registration with the FCC-designated frequency coordinator.*
- *For the 9034x-05 and 9134x-09 transmitters, both the STANDARD and LIMB LEAD modes function correctly with or without the right leg (AAMI - RL; IEC - N) electrode attached. However, for optimum performance, the RL electrode should always be used.*
- *For the 90341, 90343, and 90347 transmitters, the RA (R) lead wire must be connected to the transmitter at all times. This lead wire also serves as the transmitter's antenna.*
- *For the 90343 and 91343 transmitters, the ECG lead wires must be connected to the patient in order to perform ECG, $SpO_2$, and NIBP monitoring.*

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to digital telemetry. Refer to *Warnings and Cautions* on page 10-6 in the *ECG* chapter for cautionary disclosures related to ECG. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

***Warning:***

- ***Medical telemetry spectrum allocations may be assigned to frequencies already allotted to other priority users. Radio frequency interference from other products may disrupt or impede telemetry patient monitoring during the life of this equipment. You are urged to regularly consult with applicable local and federal regulatory agencies (e.g., FCC, FDA) regarding the locations and frequencies of other spectrum users in your geographic area. A Spacelabs Healthcare field service engineer may be able to assist you in reconfiguring your equipment frequencies to reduce the risk of interference. Spacelabs Healthcare cannot, and does not, guarantee interference-free telemetry operation.***
- ***Telemetry systems may be more susceptible to interference than hardwired systems; this may impact signal quality.***

- ***Operation of hand-held, wireless telephone equipment (cordless telephones, cellular telephones) near telemetry systems may cause interference and should be discouraged. While personal communication devices are turned on, a separation of >6.5 feet (>2 meters) should be maintained between personal communication devices and interior walls, the patient cables, and any electronic medical device to which the patient may be connected. Patients should not use any type of electronic communication equipment while connected to any electronic medical device without an on-site evaluation by the biomedical staff. Two-way radio equipment and other personal communication devices must be evaluated on site to determine if additional space limitations are needed.***
- ***The Spacelabs Healthcare digital telemetry transmitters are contra indicated for use with other medical instrumentation (e.g., respiration monitors using impedance pneumography, electrocautery) that source electrical current through the patient. Further, telemetry monitoring is contra indicated for the operating room environment.***
- ***When an unrecoverable error in the software is detected, a high-priority alarm (audio and visual) is generated and the message INTERNAL ERROR #x displays. x is either 1 or 2, depending on the nature of the failure. The ECG waveform is cleared from the display, and all user access/ control is disabled, except for a single key in the main ECG menu, labeled RESET ERROR. The user must touch the RESET ERROR key to reinitialize the module and resume patient monitoring. All arrhythmia data within the module will be lost. All trend data captured within the monitor will be retained, along with any Full Disclosure data, if such a system is present.***

In the rare event an unrecoverable software error occurs and the module is reset using the RESET ERROR key, all Module Configuration Manager (MCM) defaults will be restored. Check all user settings, including alarm settings, after pressing the RESET ERROR key to ensure that they are set as desired. If alarms are set to LEARNED in the MCM, alarms will automatically be set as defined in the explanation of learned alarms found in the *Module Configuration Manager System Administration Guide* (P/N 070-1245-xx).

### Caution:

- **This device has a limited bandwidth range of 0.05 to 30 Hz, which may adversely affect the recording of high frequency components in the ECG signal, especially when the morphology of the ECG changes rapidly.**
- **This device has a limited dynamic range of ±4 mV, which may render the device vulnerable to saturation by ECG signals with amplitudes higher than 4 mV.**
- **Patients should not use any type of electronic equipment (e.g., portable radios, cellular telephones, pagers, personal computers) while connected to any medical electronic device without prior evaluation of that electronic equipment by the biomedical engineering staff.**

# Intended Use

As an option for adult patients, additional abnormal cardiac rhythms, such as ventricular runs, PSVT, and ST segment deviations, can be detected. The digital telemetry system also provides a means for the episodic monitoring of NIBP signals to detect abnormal events, such as high and low blood pressure. Finally, it provides a means for both continuous and episodic monitoring of blood oxygen saturation signals in order to detect oxygen desaturation caused by abnormal pulmonary/circulatory functions.

***Note:***

*Episodic monitoring of NIBP values and continuous and episodic monitoring of blood oxygen saturation values are only supported in conjunction with ECG monitoring. $SpO_2$ and NIBP alarms are inhibited by ECG leads-off condition.*

The patient-worn transmitters are intended for use with either adult or neonatal patients in a hospital environment. When the NIBP option is selected in the 90343 and 91343 configurations, the NIBP feature is to be used with adult patients only.

***Note:***

*Operation of this equipment may be subject to licensing requirements by your local telecommunications authority. Please check with your Spacelabs Healthcare field service engineer.*

# Digital Telemetry System Components

The digital telemetry system consists of transmitters, diversity antennas, receiver modules, and either a receiver housing or a monitor.

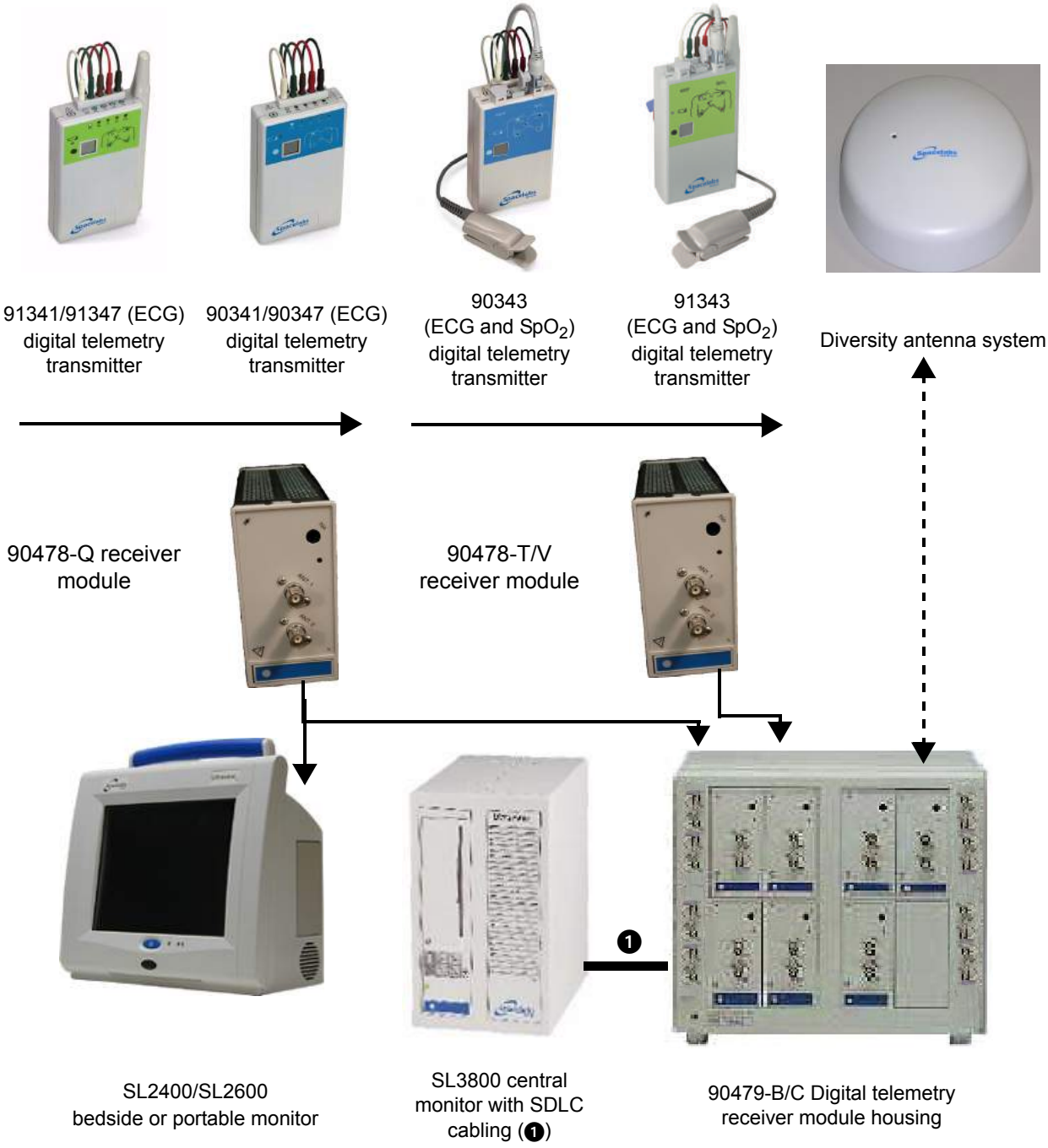

91341/91347 (ECG) digital telemetry transmitter
90341/90347 (ECG) digital telemetry transmitter
90343 (ECG and SpO2) digital telemetry transmitter
91343 (ECG and SpO2) digital telemetry transmitter
Diversity antenna system
90478-Q receiver module
90478-T/V receiver module
SL2400/SL2600 bedside or portable monitor
SL3800 central monitor with SDLC cabling (1)
90479-B/C Digital telemetry receiver module housing

*Figure 18-1: Spacelabs Healthcare digital telemetry system*

# Telemetry Transmitters

The patient-worn telemetry transmitters are small, battery-powered devices that monitor ECG activity and $SpO_2$/NIBP (90343 only) data, and transmit this information to the telemetry receiver module.

- The 90341 and 91341 use up to five lead wires and transmits two leads of ECG. Two leads may be simultaneously displayed.
- The 90343, 91343, 90347, and 91347 use up to five lead wires and transmit four leads of ECG. Two leads may be simultaneously displayed.
- The 90343 and 91343 are also capable of transmitting numerical NIBP and $SpO_2$ data. This data is simultaneously displayed with ECG waveform data.

Each telemetry channel requires its own transmitter, operating on a unique radio frequency. Telemetry receivers are tuned from the Spacelabs Healthcare monitor touchscreen to receive the available transmitter frequencies.

Up to five standard, disposable, silver/silver chloride chest electrodes are connected to the patient. The ECG lead wires are attached to these electrodes and connected to the transmitter. A patient-operated RECORD button on the transmitter initiates an ECG printout at the system printer if this feature is enabled.

***Warning:***

- ***Do not use any transmitter that has been compromised by liquid ingress.***
- ***Do not allow any liquid to enter the case. An open battery compartment is not fluid resistant.***

**Caution:**

**Clean the transmitter case with the battery door closed. Fluids, including cleaning solutions, may damage the electrical components inside and cause the transmitter to malfunction.**

***Note:***

*Clean the transmitter after each use. Refer to the Ultraview Digital Telemetry Service Manual (P/N 070-0744-xx, located on CD-ROM P/N 084-0700-xx) for cleaning and preventive maintenance instructions.*

## Selecting Options for Lead Display

Refer to *Patient Preparation and Electrode Application* on page 10-7 for lead placement illustrations.

***Note:***

*If one of the leads fails, a lead fault message appears in the upper left corner of the waveform zone. If there is no valid lead vector, the message LEADS OFF appears and an alarm tone sounds.*

**90343/91343/90347/91347 Multi-lead Transmitters**

When all electrodes are connected to the patient, leads I, II, III, AVR, AVL, AVF, and Vx are available. When no chest electrode is applied, leads I, II, III, AVR, AVL, and AVF are available using the remaining connected electrodes.

### 90341/91341 Dual-lead Transmitter

*Table 1* indicates which leads are available when various electrodes are connected. The heading for each electrode column lists both the AAMI and IEC lead designations (the IEC designations are in parentheses). Two operational modes are offered:

- STANDARD mode (chest electrode present) — Offers a choice of one V lead (V1-6), plus lead II
- LIMB LEAD mode — Offers choices of leads I, II, III, AVR, AVL, or AVF

***Note:***

*For optimum performance, the right leg electrode should always be used. However, both modes work correctly with or without the right leg (RL) electrode attached.*

*Table 1: 90341/91341 Lead Options*

| Connected Electrodes (X) | | | | Valid Lead Vectors |
|---|---|---|---|---|
| C (C) | LA (L) | LL (F) | R (R) | |
| X | X | X | X | V1-6 and II (STANDARD mode) |
| X | X | X | | III (STANDARD mode) |
| X | X | | X | I (STANDARD mode) |
| X | X | | | Total lead failure (STANDARD mode) |
| X | | X | X | II (STANDARD mode) |
| X | | | X | None (lead failure) |
| X | | X | | None (lead failure) |
| X | | | | None (lead failure) |
| | | | X | None (lead failure) |
| | | X | | None (lead failure) |
| | X | | | None (lead failure) |
| | | | | None (lead failure) |
| | X | X | | III (LIMB LEAD mode) |
| | X | | X | I (LIMB LEAD mode) |
| | | X | X | II (LIMB LEAD mode) |
| | X | X | X | I, II, III, AVR, AVL, AVF (LIMB LEAD mode) |

## Lead Fault Indicators

The 91341/91343/91347 dual-lead transmitters have blue indicators below the ECG lead wire connectors. Each indicator provides the status of its respective lead wire and flashes if its lead wire is disconnected from the skin electrode or if the skin electrode makes poor electrical contact with the patient.

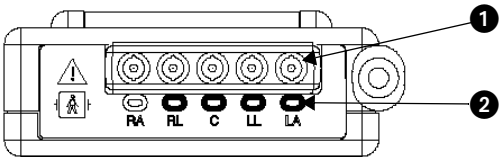



*Figure 18-2: 91341/91347 transmitter*

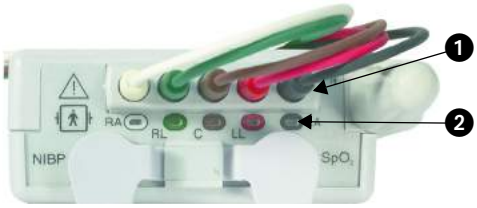



*Figure 18-3: 91343 transmitter*

❶ Lead wire connectors

❷ Lead fault indicators

## Transmitter Batteries

A 9-volt alkaline battery is recommended for standard use in the digital telemetry transmitter. A 9-volt lithium battery can be used for applications requiring extended battery service life.

Check the battery position and polarity, as illustrated at the bottom of the battery compartment. After battery installation, close and latch the compartment cover. The transmitter begins transmitting as soon as the battery is in place.

***Note:***

- *Insert a battery only when the transmitter is being used with a patient. Remove the battery when the transmitter is not in use.*
- *The following description of transmitter operation is valid only for 9-volt alkaline and 9-volt lithium batteries and does not apply to any other type of battery.*
  - *When the battery voltage falls below approximately 7.0 volts, the low-battery LED on the transmitter will flash once every 15 seconds. The LOW BATTERY message may appear after the low-battery LED on the transmitter begins to flash. When the battery voltage falls below 6.0 volts, the low-battery LED flashes once every two seconds. When the battery voltage falls below 5.5 volts, the $SpO_2$ and NIBP functions shut down.*
  - *The LOW BATTERY message appears and an alarm tone sounds (if LO BAT is set to ON) when the transmitter battery voltage falls below approximately 7.0 volts. When this message appears, the transmitter has approximately three hours of operating time left, depending on transmitter type, selected options, and type of battery.*

Refer to *Digital Telemetry* on page 32-3 for information on disposal of used batteries.

### Setting Battery Status Alarms

The telemetry battery alarm tone and a *LOW BATTERY* message appears in the ECG zone alert you to a low-battery condition in the transmitter. You can disable the low-battery alarm tone if your bedside or central monitor is configured to do so.

**To control low-battery alarms:**

- Touch ECG.
- Touch SETUP.
- Touch TM SETUP.
- Select LO BAT / ON or OFF.

## Telemetry Receiver Module

The 90478 telemetry receiver module plugs into a bedside monitor or into a digital telemetry module housing. The receiver module receives patient vital signs data from the patient-worn transmitter. This data is reconstructed by the receiver module, is displayed on the monitor, and is analyzed as described in *ECG* on page 10-5*, Arrhythmia* on page 11-3*,* and *ST Analysis* on page 12-3. Also refer to *SpO2* on page 17-5.

A telemetry receiver module must be tuned to a transmitter's assigned frequency before it can receive data from that transmitter. Qualified personnel can use the **ECG TM Setup** menu to tune the receiver module at the monitor to which the receiver module is directly connected.

**To tune a receiver module:**

- Touch ECG.
- Touch SETUP.
- Touch TM SETUP.
- Touch the hidden key three times.
- Touch SET TM CHAN.
- Select the digit to change. Use the ↑ ↓ keys to select the value for that digit.
- Repeat for all digits as necessary.
- Touch STORE.

**Caution:**

**Do not install a telemetry receiver module into a bedside monitor that is currently equipped with any other ECG module, hardwired or telemetry (or $SpO_2$ module or NIBP module if a 90343 or 91343 transmitter is operating with that specific receiver module). Doing so may cause inaccurate patient data displays at remote monitors.**

***Note:***

- *Telemetry transmitters have preassigned channel frequencies (or numbers) that cannot be changed. The channel number is identified on the back of the transmitter's case.*
- *Only qualified personnel should tune telemetry receiver modules to receive data from a telemetry transmitter. Telemetry receiver modules must be used with a transmitter on the same frequency.*
- *Qualified service personnel should set the telemetry transmitter's frequency band via the Module Configuration Manager feature.*

## Telemetry Receiver Module Housing

The telemetry receiver housing can hold up to eight separate telemetry receiver modules. Except for the ON/OFF switches, there are no operator controls on the module housing. For normal operation with AC mains power applied, the AC mains indicator light on the front panel of the module housing must be illuminated. The housing and eight modules retain the operating configuration for up to ten minutes during an AC mains power interruption.

***Warning:***

***All system connections must be made by Spacelabs Healthcare personnel only. Changes or modifications not expressly approved by Spacelabs Healthcare will void the user's authority to operate the equipment.***

# Display Detail

Signal detection is indicated on your monitor when an ECG signal appears next to the ECG parameter key in the zone assigned to receive the transmitted telemetry channel. The transmitter's channel number is always identified above the waveform, to the left of the ECG key.

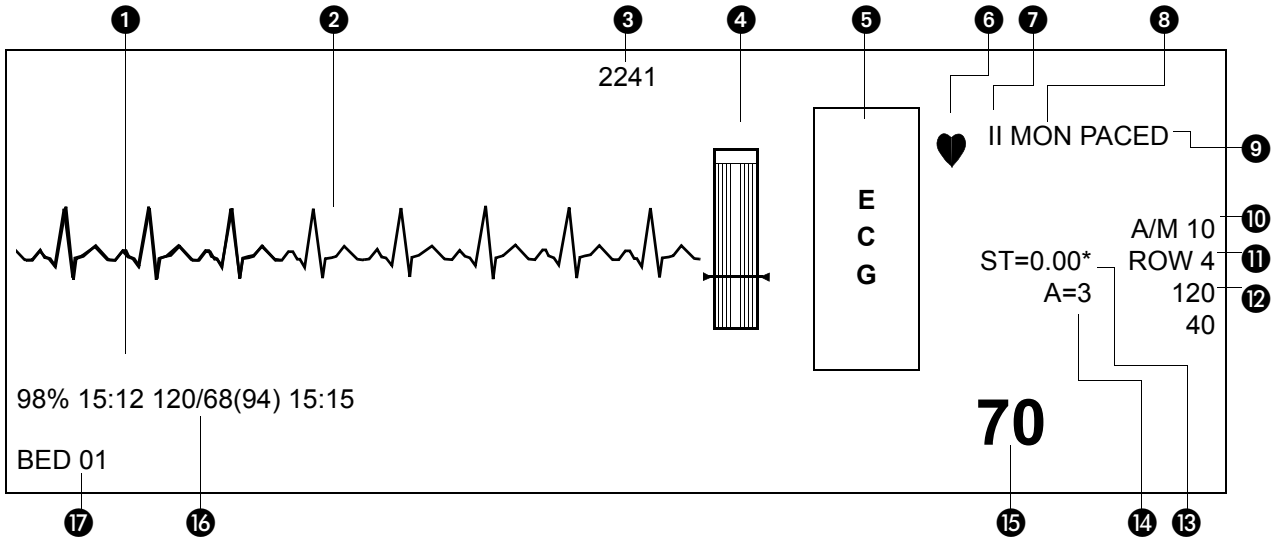



*Figure 18-4: Bedside or central monitor*

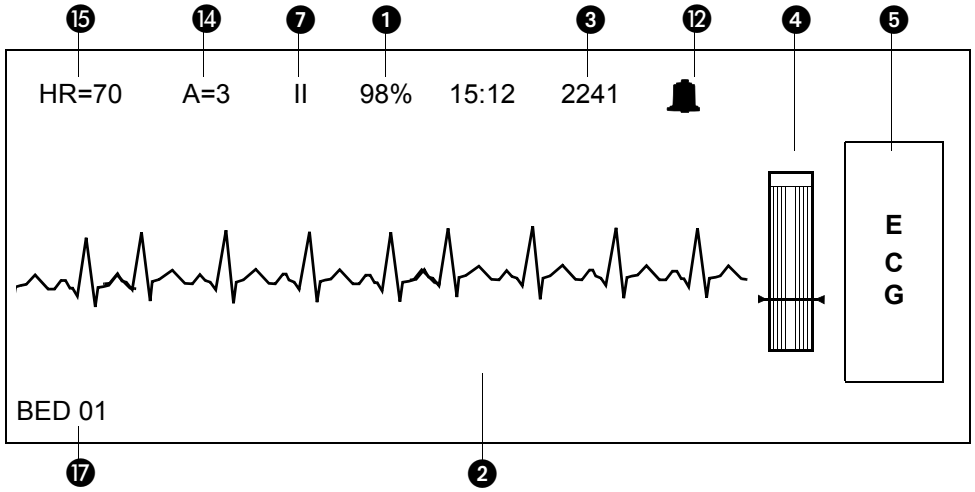



*Figure 18-5: Central monitor — split view (with NIBP turned OFF and $SpO_2$ turned ON)*

***Note:***

- *$SpO_2$ does not display if it is turned OFF.*
- *A bell symbol follows the percent (%) symbol if the $SpO_2$ alarm is enabled.*
- *The time of the $SpO_2$ reading (15:12) only displays when $SpO_2$ mode is set as EPISODIC.*




*Figure 18-6: Central monitor — split view (with NIBP and $SpO_2$ turned ON)*

***Note:***

- *NIBP data replaces the count of abnormal events and lead information (split-view only).*
- *The time of the NIBP reading (15:15) always displays because NIBP is episodic, but the time of the $SpO_2$ reading (15:12) only displays when $SpO_2$ mode is set as EPISODIC.*

- *$SpO_2$ does not display if it is turned OFF. $SpO_2$ displays immediately above the bed and patient name if it is turned ON.*
- *A bell symbol follows the percent (%) symbol if the $SpO_2$ alarm is enabled and follows the mean pressure value if NIBP alarms are enabled.*

❶ $SpO_2$ reading and time of last reading (EPISODIC mode only)

❷ ECG waveform for first lead

❸ Telemetry channel number

❹ Sensorwatch signal strength indicator

Shaded area (waveform index, WFI) expands up proportionally to signal strength; horizontal line indicates minimum signal level.

No shading (lowest waveform index) corresponds to no detected signal strength or a faulty sensor.

❺ ECG key for first lead

❻ QRS indicator (flashes once per detected beat)

❼ ECG lead designator

❽ Display resolution (MONITOR or EXTENDED)

❾ Paced operation indication (pacemaker detection is enabled)

❿ VEs per minute alarm limit *****

⓫ Ventricular run alarm limit *****

⓬ ECG rate alarm limits. Split-view central monitors display a bell symbol when alarms are enabled. Bedside monitors display the rate alarm limits (120/40).

⓭ ST segment level for first lead (The asterisk indicates that ST alarms are enabled, and only appears in ADULT mode, with the ST segment analysis option.)

⓮ VEs per minute counter *****

⓯ Current heart rate

⓰ Noninvasive blood pressure systolic/diastolic (mean) reading and time of last reading.

⓱ Bed/patient ID

* *Only appears with the Multiview I or II option in ADULT mode, with arrhythmia detection enabled.*

The current (or latest) NIBP reading taken may be displayed when the NIBP parameter is enabled and the 90217 ABP monitor is set up correctly. The current systolic, diastolic, and mean values, along with the time of the reading, are displayed as shown in *Figure 18-4* on page 18-12. The displayed values are replaced by **???** when no valid values have been acquired from the 90217 ABP monitor.

**To display the NIBP data:**

- Touch ECG.
- Touch CHANNEL FORMAT.
- Select NIBP / ON.

# Setting up Telemetry Monitoring

## Assigning a Telemetry Channel

***Note:***

*When connecting a new patient to a transmitter, make sure the prior patient's information has been purged.*

Your central monitor can only display a telemetry channel after that channel has been assigned a specific bed name. Refer to the following Quickstart to assign a specific bed name to a telemetry channel and to assign the bed to a specific display zone.

Your central monitor can be configured to remember the bed name assigned to individual telemetry channels. These beds are permanently assigned until you unassign or reassign them. Refer to the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx) for more information.

Previous NIBP readings can be displayed using the tabular or graphic trend features on the monitor. NIBP readings are collected by the system on a minute-by-minute basis and can be displayed in the same manner as any other monitored parameter. Refer to *Trends* on page 28-3 for more information.

**To initiate telemetry ECG monitoring:**

- Select a transmitter.
- Note its channel number.
- Attach lead wires to transmitter.
- Attach lead wires to electrodes.
- Apply electrodes to patient.
- Install a transmitter battery.
- Close the transmitter case.

**To set up the central monitor for ECG (if bed name is not remembered):**

- Touch key label that matches transmitter's frequency.
- Select bed/room number for transmitter channel.

**To set up the central monitor for ECG:**

- Touch MONITOR SETUP.
- Touch SCREEN FORMAT.
- Select subnet and bed/room number.
- Select ECG and then desired zone.

# Enabling and Adjusting Alarms

Alarm limits for multiparameter telemetry are adjusted the same way as the alarm limits for other parameters. However, for multiparameter telemetry you must first select the parameter. Once that selection is made, adjustments are made to ECG alarms, NIBP alarms, and $SpO_2$ alarms as described in *Enabling and Adjusting Alarms* on page 10-17, *Enabling and Adjusting Alarms* on page 16-13, and *Enabling and Adjusting Alarms* on page 17-13. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms. Refer to *NIBP Messages* on page 18-23 for status messages relating to NIBP alarms.

**To set or adjust multiparameter telemetry alarms:**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch ECG ALARM LIMITS, NIBP ALARM LIMITS, or SPO2 ALARM LIMITS.
- Select parameter to adjust.
- Use the arrow keys to adjust.

***Warning:***

***When an unrecoverable error in the software is detected, a high-priority alarm (audio and visual) is generated and the message INTERNAL ERROR #x displays. x is either 1 or 2, depending on the nature of the failure. The ECG waveform is cleared from the display, and all user access/control is disabled, except for a single key in the main ECG menu, labeled RESET ERROR. The user must touch the RESET ERROR key to reinitialize the module and resume patient monitoring. All arrhythmia data within the module will be lost. All trend data captured within the monitor will be retained, along with any Full Disclosure data, if such a system is present.***

In the rare event an unrecoverable software error occurs and the module is reset using the RESET ERROR key, all Module Configuration Manager (MCM) defaults will be restored. Check all user settings, including alarm settings, after pressing the RESET ERROR key to ensure that they are set as desired. If alarms are set to LEARNED in the MCM, alarms will automatically be set as defined in the explanation of learned alarms found in the *Module Configuration Manager System Administration Guide* (P/N 070-1245-xx).

# Discharging a Patient and Acknowledging Signal Loss

When a telemetry signal is lost because the transmitter is out of range or the battery is depleted, return the patient into antenna range and check that the battery is functioning properly. The ECG waveform automatically displays when the lost signal returns.

After eight seconds of signal loss, the message *SIGNAL LOSS PERMANENT* appears in the monitor's waveform zone and the monitor initiates the signal loss alarm. Selecting NO to this message cancels the intermittent signal loss alarm.

**Caution:**

**$SpO_2$ and NIBP data may not be displayed when the *INTERMITTENT SIGNAL LOSS* message appears.**

The process of discharging a patient begins by removing the battery from the transmitter. All monitors displaying this telemetry channel display the message *IS SIGNAL LOSS PERMANENT?* in the waveform zone. Only the monitor hosting this telemetry channel displays the YES and NO keys below this message.

1 Touch YES when the *IS SIGNAL LOSS PERMANENT?* message appears.

  The message *DISCHARGE THIS PATIENT* appears. (Touch NO to cancel the discharge process and suspend the alarm.)

2 Touch YES when the *DISCHARGE THIS PATIENT* message appears.

  The message *PURGES DATA - ARE YOU SURE?* appears. (Touch NO to cancel the discharge process.)

3 Touch YES a third time to discharge the patient and erase all patient data from memory. (Touch NO to cancel the discharge process.)

**To discharge a patient:**

- Remove battery.
- Disconnect the transmitter from the patient.
- Touch YES to confirm signal loss is permanent.
- Touch YES to discharge.
- Touch YES to purge data.

**To acknowledge signal loss, select NO.**

# Controlling Patient-Initiated Recordings

If the Patient Record function is activated (PT RECORD is YES) in the **ECG TM Setup** menu, the patient can initiate a recording by pressing the RECORD button on the front of the transmitter.

**To control the transmitter's Patient Record function:**

- Touch ECG.
- Touch SETUP.
- Touch TM SETUP.
- Select PT RECORD / YES or NO.

# Multiparameter Telemetry (NIBP)

The 90343 and 91343 digital telemetry multiparameter transmitters send $SpO_2$ data plus NIBP data acquired by the 90217 ambulatory blood pressure (ABP) monitor (refer to *Figure 18-7*) to the 90478 digital telemetry receiver. The 90478 receiver displays the patient's $SpO_2$ data and episodic NIBP data, and triggers alarms based on thresholds set at the patient monitor. For more information on $SpO_2$ monitoring, refer to *Setting Up SpO2 Monitoring* on page 17-8.



*Figure 18-7: 90217 ABP Monitor*

## Setting Up the ABP Monitor

The 90217 ABP monitor is a small, lightweight, battery-powered unit designed to take blood pressure measurements. Refer to the *90207/90217 ABP Monitors Operations Manual* (P/N 070-0137-xx) and to either the *90121 ABP Report Management System Operations Manual* (P/N 070-0529-xx) or the *92506 ABP Report Management System Client Application Operations Manual* (P/N 070-0932-xx) for additional information on this product, its initialization by a direct PC interface, patient preparation, and event codes.

The 90217 ABP monitor must be initialized prior to the monitoring of each patient. Initialization is accomplished using the 90121 ABP Report Management System.

**Caution:**

**Failure to initialize the ABP monitor as specified may result in the display and storage of incorrect measurements or measurements acquired from a prior patient. The operator must initialize the ABP monitor before each patient use.**

## Setting Up NIBP Monitoring

NIBP uses oscillometric monitoring to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures. The pressure readings are sent from the ABP monitor to the patient-worn transmitter by a connecting cable. The transmitter includes the NIBP readings when communicating with the 90478 telemetry receiver module using the radio frequency data link. Valid measurements are displayed on the Spacelabs Healthcare monitor and stored for trending. NIBP readings that are not successfully transmitted by the ABP monitor to the receiver module within 24 hours of their measurement are unavailable for display or trending.

**To set up NIBP monitoring:**

- Initialize the ABP monitor as described in the ABP manuals referred to previously.
- Apply appropriate cuff to patient.
- Attach cuff to ABP monitor.
- Connect NIBP adapter cable (P/N 012-0588-xx) between ABP monitor and transmitter.
- Touch ECG.
- Touch CHANNEL FORMAT.
- Select NIBP / ON.

**After the ABP monitor is initialized, prepare the patient for monitoring as follows:**

1 Power ON the ABP monitor and wait for the monitor to perform self-tests. When the LCD displays the current time, the ABP monitor is ready for operation.

2 Strap the ABP monitor to the patient's hip opposite the side on which the cuff is worn. Secure the monitor using the patient's own belt or the ABP pouch strapped over the opposite shoulder. When using the shoulder strap, use the patient's belt or the belt supplied with the monitor to provide additional security.

3 Measure the circumference of the limb at the point where the cuff is to be applied to select the proper cuff. Match the limb measurement to the range of appropriate circumferences (in centimeters) specified on each cuff (refer to *Table 2*).

*Table 2: Cuff Size by Limb Circumference*

| Cuff Size | Limb Circumference |
|---|---|
| Pediatric | 13 to 20 cm |
| Small adult | 17 to 26 cm |
| Average adult | 24 to 32 cm |
| Large adult | 32 to 42 cm |
| Extra-large adult | 38 to 50 cm |

**Caution:**

- **This product contains natural latex rubber components to which some people may be allergic. These components include the bladder and the first four inches of tubing extending from the cuff.**
- **Refer to Warnings and Cautions on page 16-4 for additional cautionary disclosures related to NIBP measurements.**

***Note:***

- *Use only Spacelabs Healthcare cuffs with this monitor. Using other manufacturer's cuffs may result in inaccurate readings, even if the manufacturer's recommended size is observed.*
- *If the cuff is too small, pressure readings may be falsely high; a cuff that is too large produces a falsely low reading. The bladder can be positioned in the cuff for either the left or right arm.*
- *Use only single hose cuffs to ensure proper operation. Spacelabs Healthcare's hoses are non-conductive with respect to defibrillator discharge effects.*
- *Leakage currents are not affected by the high-level output in the 90478. The patient is electrically isolated from the patient monitor by the RF link.*

4 Position the cuff so that the center of the inflatable bladder is directly over the brachial artery. The center of the bladder location is marked on the outside of the cuff. Once the proper position is determined, the cuff must be tightened to ensure that it is equally snug at the top and bottom edges and that it is not kinked. This is especially important on larger arms. Insert a finger between the cuff and the limb to ensure it is not too tight. It may be necessary to wrap the cuff with its tail at an angle to achieve uniform tightness. If the cuff is not equally snug at the top and bottom edges, the number of readings available will be limited and the monitor may indicate that the cuff is improperly applied.

5 To avoid reading errors because of hydrostatic pressure differences, position the patient's arm so that the level of the cuff on the arm is near the level of the heart after the cuff is applied.

6 Lead the hose up the arm and place it across the back of the patient. Drape the hose so it does not cause the patient discomfort and is not pinched shut by too tight a radius. *Figure 18-8* displays the most common positions for the cuff hose.

7 Connect the hose to the monitor.

8 Take one or more blood pressure readings to verify proper monitor operation. Push the START/STOP key to begin a measurement.

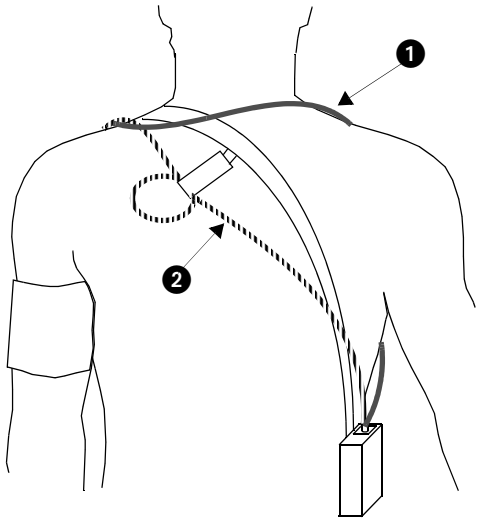



*Figure 18-8: Common cuff hose positions*

1 Alternative #1

2 Alternative #2

9 Configure the 90478 receiver for operation with the 90343 or 91343 transmitter attached to the 90217 ABP monitor. The NIBP measurement displays in numeric format on the monitor. The values of the measurement are displayed as **???** until a valid NIBP measurement is taken.

10 Interconnect the adapter cable between the communications port on the ABP monitor and the NIBP port on the 90343 or 91343 transmitter, as shown in *Figure 18-9*.

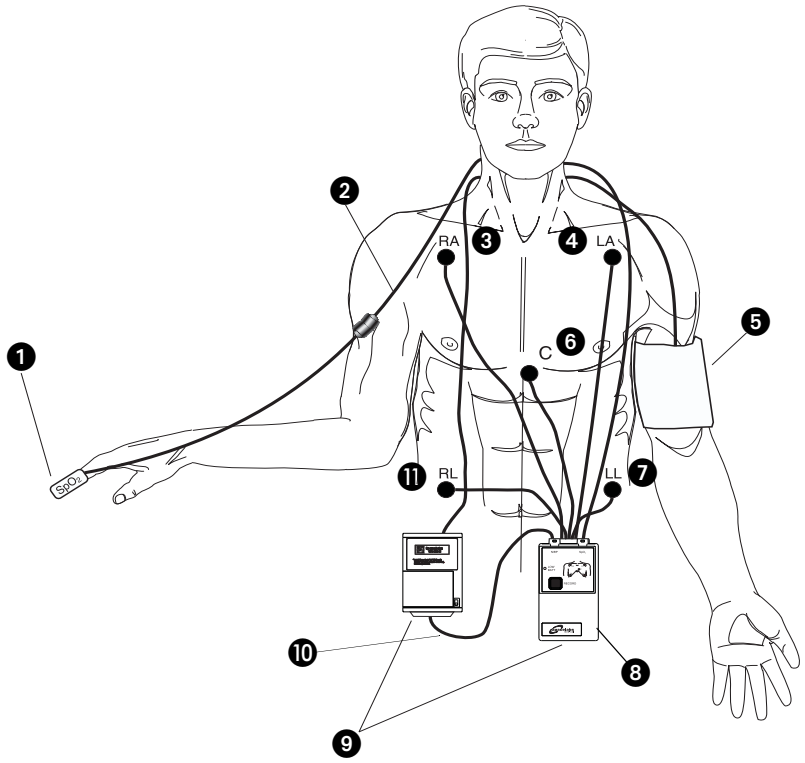



*Figure 18-9: Transmitter ECG, $SpO_2$, and ABP monitor connections*

1. $SpO_2$ sensor
2. $SpO_2$ adapter cable
3. RA
4. LA
5. NIBP cuff
6. C
7. LL
8. Telemetry transmitter
9. 90217 ABP monitors and 90343 or 91343 telemetry transmitters

   Monitors and transmitters may be placed in pouches and attached to the patient's belt.
10. NIBP adapter cable
11. RL

## Patient Factors Affecting Readings

Proper cuff selection and application is critical in ensuring the accuracy of NIBP readings. Measure the circumference of the limb at its midpoint. Match the limb measurement to the range of appropriate circumferences (in centimeters) specified on each cuff. Undersizing the cuff results in the greatest chance of error, so a variety of cuff sizes should be available to accommodate your full patient population.

Apply the cuff snugly. When the cuff is properly applied to an adult, you should be able to insert one finger between the cuff and the arm. If you can insert two fingers, the cuff is too loose, which may result in falsely elevated readings. Ensure that the hose is not kinked when the cuff is applied.

During blood pressure measurement, the inflated cuff reduces blood flow to the limb to which it is applied. Do not apply a cuff to a limb that has restricted blood flow. Check the patient periodically.

Excessive patient movement, speech, or muscle contractions as a result of severe pain or shivering can interfere with automated NIBP readings. Ensure that the patient is quiet and not moving during NIBP readings, just as you would for manual readings. The patient must avoid applying external pressure to the cuff during readings. Institute measures to minimize shivering and alleviate pain.

Some arrhythmias may cause beat-to-beat pressure fluctuations that can make obtaining NIBP readings more difficult. If it becomes difficult to obtain readings in the presence of arrhythmia, pressure should be temporarily verified using another method (i.e., ausculatory, oscillometric). Pressure also varies cyclically with normal respiration. With deep respirations or in certain patients, this effect may be enhanced, increasing reading variability.

For patients in shock, indirect methods of measuring pressure (auscultatory, oscillometric, Doppler) may not be reliable because of peripheral vascular changes. These changes include peripheral vasoconstriction and diminished peripheral circulation resulting from shunting of blood to central organs. In some cases, peripheral pulses or Korotkoff sounds may be diminished or disappear in spite of adequate blood pressure. In such cases, measuring a cuff pressure may be impossible or give misleading results. Direct blood pressure measurements (invasive) should be considered in patients with signs of shock or any patient who rapidly becomes unstable for unknown reasons.

# Status Messages

**Caution:**

**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

## Telemetry Messages

The following are general telemetry messages that apply to the patient-worn transmitters.

***INTERMITTENT SIGNAL LOSS*** — Indicates that the patient may be out of antenna range or the battery is depleted. Return the patient into antenna range. Check that the battery is functioning properly. A low-priority alarm occurs after 10 seconds in this condition.

***LOW BATTERY*** — Indicates the battery is weak. After this message appears, the battery has approximately three hours of useful life left (depending on the type of battery used). Install a new battery. A low-priority alarm occurs if the Setup menu's LOW BAT ON/OFF key is set to ON.

***SIGNAL INTERFERENCE*** — Indicates, through the displayed triangle-shaped squelch waveform, that an interfering signal has been detected. The patient's signal can no longer be detected because of interference from a stronger signal source lasting more than 0.5 seconds. A low priority alarm occurs whenever this message appears in the waveform zone.

***IS SIGNAL LOSS PERMANENT?*** — Indicates no RF signal is being detected.

## $SpO_2$ Messages

Telemetry products use different text for $SpO_2$ status messages than non-telemetry products. Refer to *Table 1* on page 17-22 for information on interpreting the telemetry messages.

## NIBP Messages

The 90217 ABP monitor provides an extensive set of result codes that indicate the status of the monitor and the potential causes of an inability to take a valid reading.

When an error condition is detected, the NIBP parameter value immediately changes to **???** and an alarm is triggered. The alarm condition persists until a new NIBP reading is taken.

Telemetry products display their status messages within the ECG's display zone, so the following ECG status messages take priority over other NIBP messages:

- *LEADS OFF*
- *NOISY SIGNAL*

The monitor displays the following messages to provide ABP status information to the caregiver. These messages summarize the 90217 ABP monitor event codes. Refer to the *90207/90217 ABP Monitors Operations Manual* (P/N 070-0137-xx) for a complete list of the event codes.

***NIBP UNAVAILABLE (xx)*** — Appears when the 90217 ABP monitor detects an internal error condition defined by the code (xx). Typically, this requires the ABP monitor to be removed from service.

***NIBP READING FAILURE (xx)*** — Appears when the 90217 ABP monitor is unable to make a reading. The code (xx) defines the cause of failure.

***NIBP LOOSE OR NO CUFF*** — Appears when the cuff inflates in a manner indicating that it is not attached to the patient correctly. Also displays when an air leak is detected in the pneumatic system, preventing a reading from being taken.

***NIBP READING CANCELLED*** — Appears when the patient presses the START/STOP button on the ABP monitor, halting a reading in progress.

***NIBP LOW BATTERY*** — Appears when the primary (3 × AA) battery voltage is low. Replace with fresh batteries.

***NIBP KINKED HOSE*** — Appears when the pressure value increases too rapidly, indicating a kinked hose or other restriction.

***NIBP EVENT CODE (xx)*** — Appears when the event code returned from the ABP monitor is not defined into one of the other messages.

# NIBP Troubleshooting Guide

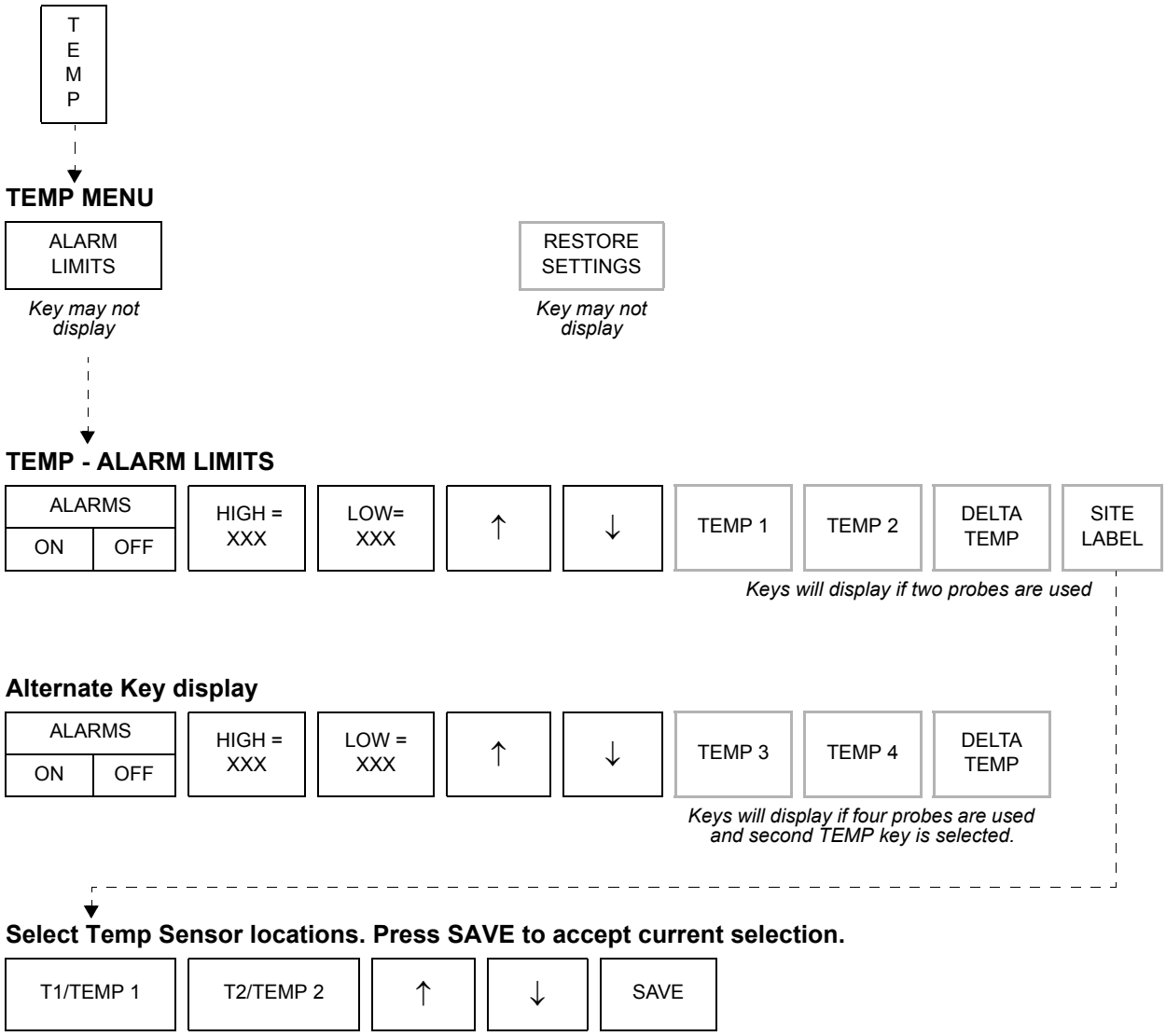
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **No NIBP displays** | ■ Adapter cable is not inserted correctly. | ■ Remove and re-insert the adapter cable. |
| | ■ NIBP is not enabled on the 90343, 91343, or 90478. | ■ Enable the NIBP function by setting the transmitter DIP switch 5 to ON and DIP switch 8 to OFF. For 90478, turn ON ENHANCED VITAL SIGNS in the Module Configuration Manager (refer to the *Module Configuration Manager System Administration Guide, P/N* 070-1245-xx). |
| | ■ 90217 ABP monitor is not properly initialized. | ■ Re-initialize the 90217 ABP monitor using the 90121 ABP Report Management System. |
| | ■ 90343/91343 low battery indicator is constantly illuminated. | ■ Contact your biomed or a qualified field service engineer. |
| **No NIBP readings can be obtained** | ■ Incorrect or inoperative cuff is in use. | ■ Replace with a cuff known to be operative. |
| | ■ Tubing is kinked. | ■ Locate the kink and straighten the tubing. |
| | ■ Some arrhythmias (e.g., atrial fibrillation and frequent ventricular ectopy) may cause a single or repeated failure to obtain a reading (may be because of true beat-to-beat variations in pressure). | ■ Document arrhythmia, if present, verify pressure using another method, then follow hospital procedure for care of this type of patient. |
| | ■ Excessive patient motion or muscle contractions associated with shivering or severe pain. | ■ Ensure the patient is quiet with minimal movement during NIBP readings; minimize the patient's shivering. |
| | ■ Blood pressure is outside measurement range. | ■ Verify extremely high or low pressure using another method. |

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Intermittent or complete failure to operate** | ■ 90217 ABP monitor error. | ■ Remove the 90217 ABP monitor from service, record the event code, and contact your biomed or a qualified field service engineer. |
| **Apparent incorrect value** | ■ Wrong size cuff for patient. | ■ Measure the patient's limbs at the midpoint. Match the limb measurement to the range specified on the cuff (undersizing the cuff results in the greatest degree of error). |
| | ■ Cuff is damaged. | ■ Replace with a good cuff. |
| | ■ Excessive patient motion, shivering, or severe pain. | ■ Ensure the patient is quiet with minimal movement during NIBP readings. Minimize the patient's shivering. |
| | ■ False high readings may be the result of venous congestion caused by frequent readings. | ■ Reduce frequency of readings. |
| | ■ Cuff is too loose or positioned incorrectly. | ■ Tighten the cuff or reposition it appropriately. |
| **90217 ABP monitor display is incorrect** | ■ Low or no power. | ■ Check the batteries for a full charge. If needed, replace or recharge the batteries. |
| | ■ May be one of the following: time-out, no reading because of air leak in the system, improper cuff size, cuff not properly attached to the 90217 ABP monitor. | ■ Isolate the cause and correct the problem. |
| **No NIBP alarms are displayed** | ■ ECG "Leads Off" condition exists. | ■ Re-attach ECG lead wires to the patient and resume ECG monitoring to clear pending ECG alarms. |
| | ■ Higher priority alarm condition is present. | ■ Clear current alarm condition and/or re-prioritize NIBP alarms in the Module Configuration Manager. |
| | | ■ When NIBP alarms are ON, all NIBP alarm conditions cause the parameter value (or **???**) to blink according to the alarm priority set using the Module Configuration Manager. |

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Variable readings occur** | ■ Some arrhythmias may cause beat-to-beat pressure and NIBP readings. | ■ Document arrhythmia, if present, verify pressure using another method, then follow hospital procedure for care of this type of patient. |
| | ■ Larger-than-normal influence of respiratory phases on blood pressure (inspiratory fall in blood pressure; expiratory rise). | ■ NIBP software usually compensates for normal variation. |
| **No NIBP readings or questionable values in the presence of shock** | ■ Peripheral vascular changes experienced during shock may reduce the reliability of blood pressure readings obtained with any indirect method. Peripheral pulses may be diminished or absent. | ■ Consider invasive pressure measurements in patients with symptoms of shock or in any patient who rapidly becomes unstable for unknown reasons. |
| **90217 ABP monitor displays “LLL” and alarm sounds** | ■ Low main battery condition. | ■ Turn OFF the 90217 ABP monitor and replace the batteries within 60 seconds after removal to continue monitoring. |
| **Cuff too tight** | ■ Cuff is placed on patient too tightly. | ■ Reposition the cuff. |
| | ■ Air pump is staying on too long. | ■ Return the unit to Spacelabs Healthcare for service. |
| **Cuff too loose** | ■ Cuff is placed on the patient too loosely. | ■ Reposition the cuff. |
| | ■ Air pump is not staying on long enough. | ■ Return the unit to Spacelabs Healthcare for service. |

# Temperature

## Directory of Keys



# Temperature

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## Overview

You can monitor up to four temperature inputs. When two temperatures from the same module are being monitored, a delta value (temperature difference between the two readings) is calculated.

***Note:***

- *Temperatures are displayed in degrees centigrade only. You can set independent high and low alarm limits for each temperature, and for the delta temperature.*
- *To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

## Setting Up Temperature Monitoring

Attach the temperature probe(s) to the patient and then to the module. The TEMP key and temperature values appear on the monitor display. Touch TEMP to display the **Temperature** menu.

**To set up temperature monitoring:**

- Attach the temperature probe(s) to the patient.
- Plug the temperature probe(s) into the module.
- Touch TEMP.
- Select additional keys as needed during monitoring.

# Display Detail

Temperature readings appear on the monitor display as soon as you plug a temperature probe into the module.

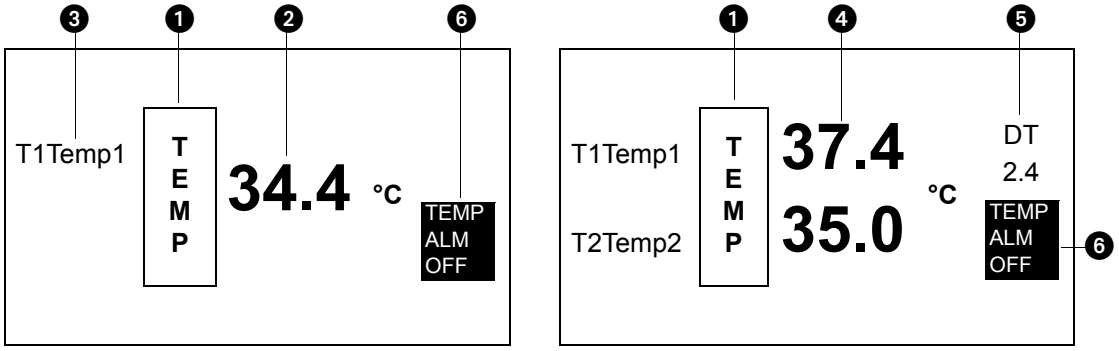



*Figure 19-1: Temperature display*

1. TEMP parameter key
2. Single channel temperature reading
3. Temperature label
4. Two temperatures (T1/T2 or T3/T4)
5. Delta temperature (DT)
6. Status of temperature alarms

***Note:***

*When alarm limits are set on more than one temperature, individual alarm limits are replaced by alarm ON/OFF status indicators.*

# Enabling and Adjusting Alarms

High and low alarm limits can be set for T1 (T3), T2 (T4), and for the difference between two temperatures (DT). Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To enable and adjust alarms:**

- Touch TEMP.
- Touch ALARM LIMITS.
- Select TEMP 1, TEMP 2, TEMP 3, TEMP 4, or DELTA TEMP.
- Select ALARMS / ON.
- Select HIGH= or LOW=.
- Use the arrow keys to adjust.

# Setting Temperature Sensor Site Labels

You can select a site label that indicates the location of the temperature sensor by using the **Site Label** menu.

Touch the SITE LABEL key to access this menu. Then select which temperature probe you wish to label (T1 or T2). Press the up or down arrow until the appropriate site label is displayed in the key. Site label selections will not take effect until the SAVE key is touched. Site labels will display onscreen and in trends.

Available selections for site labels are esophageal (esoph), rectal (rect), skin, bladder (blad), tympanic (tymp), axillary (axil), pulmonary artery (pa), central venous (cv), blood, (blood)
myocardial (myo), nasopharyngeal (naso), and core (core).

**To select a temperature sensor site label:**

- Touch TEMP.
- Touch SITE LABEL.
- Select T1/TEMP 1 or T2/TEMP 2.
- Use the arrow keys to select the site label.
- Touch SAVE.

# Printing Temperature Readings

You can send currently displayed temperature readings to a bedside or system printer. Refer to *Printing* on page 9-5 for system printing information.

**To print current temperature readings:**

- Touch RECORD.
- Touch TEMP while it flashes.

# Temperature Alarm Delays

*Table 1: Temperature Alarms*

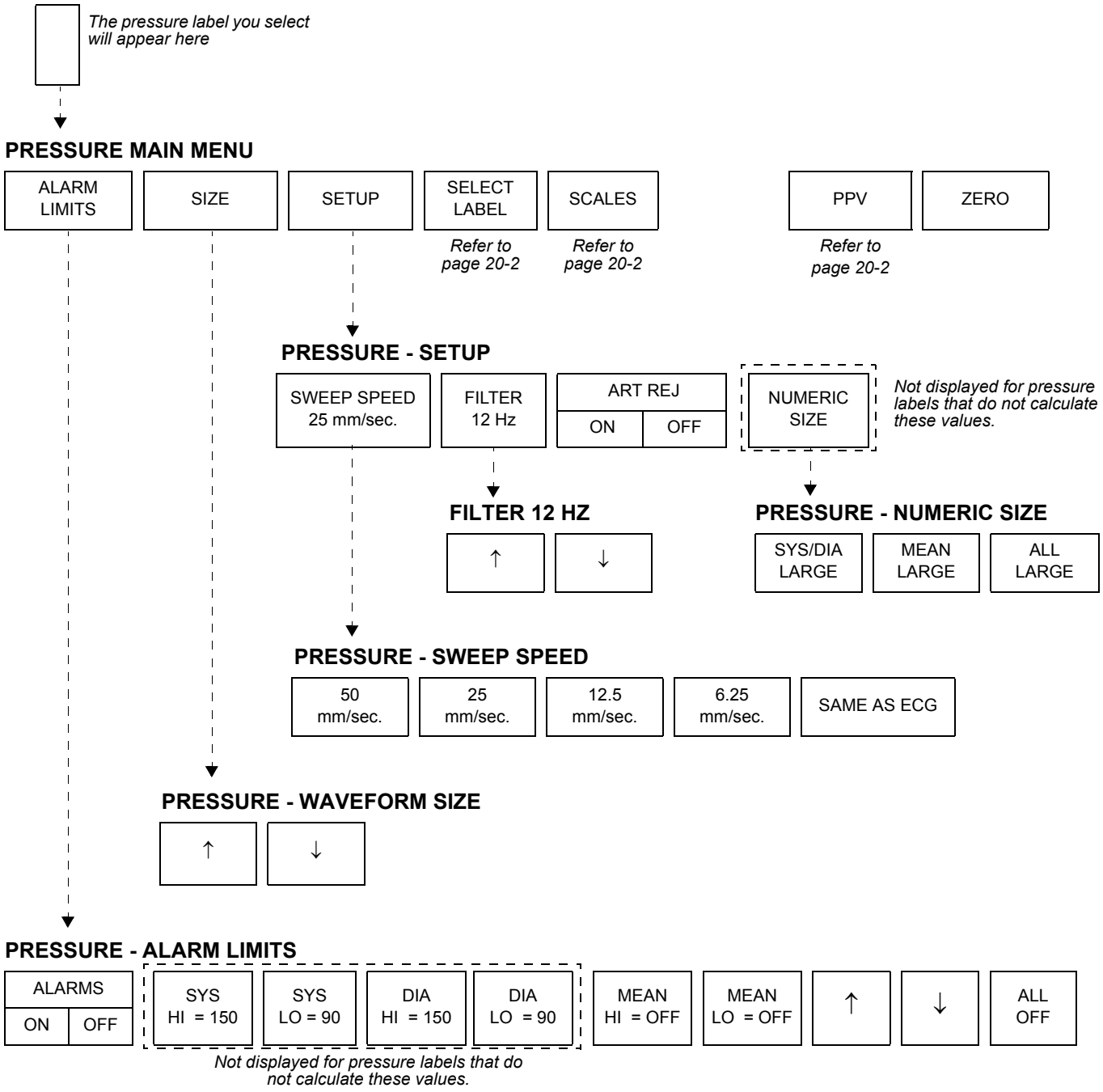
| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Temp High | 0.1° to 50° C | Less than 12 seconds |
| Temp Low | 0.0° to 49.9° C | |

# Temperature Troubleshooting Guide

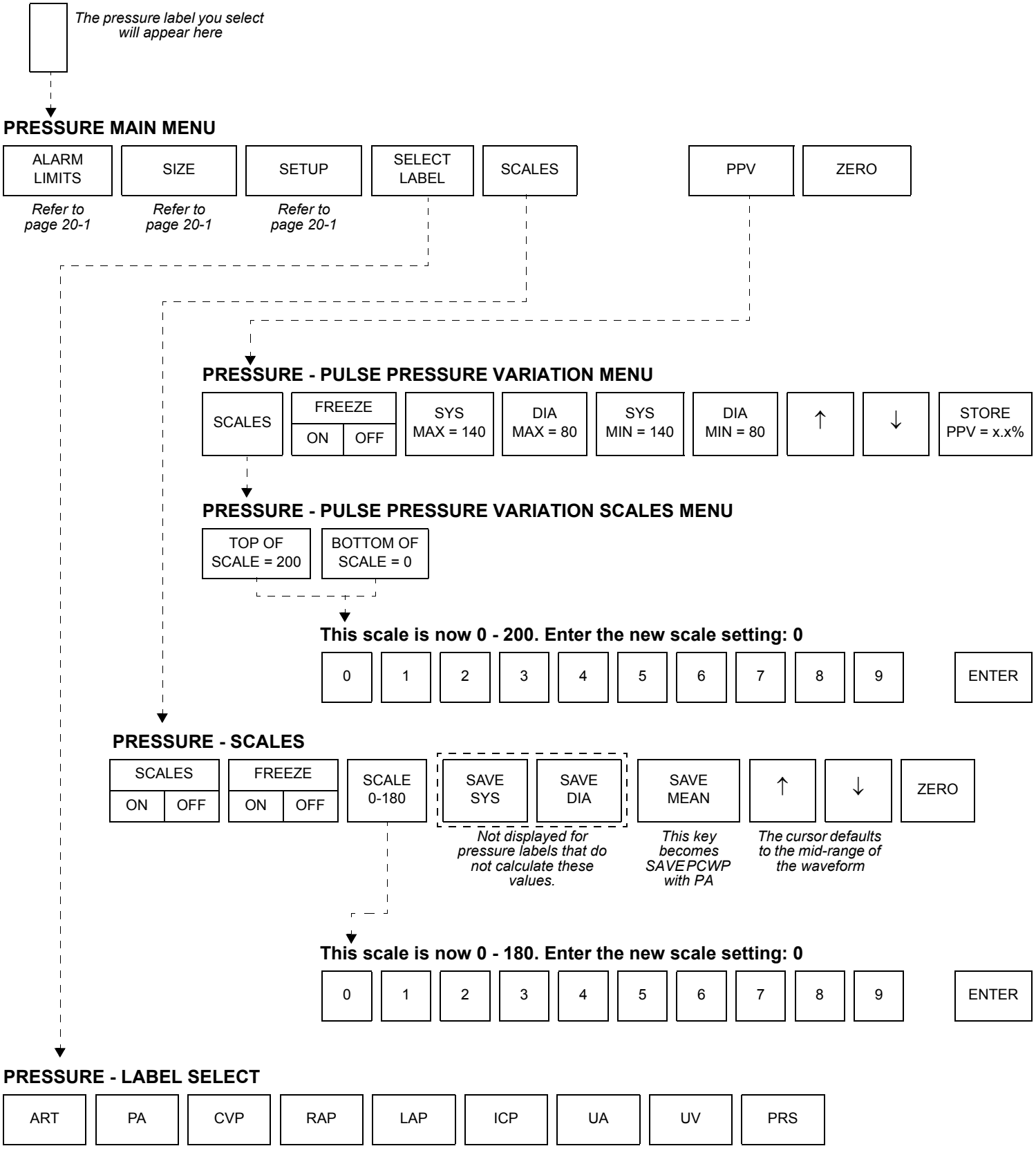
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Intermittent or no operation** | ■ Module error. | ■ Contact your biomed or a qualified field service engineer. |
| **Temperature not displayed** | ■ Module is not inserted correctly. | ■ Reinsert the module. |
| | ■ Probe is not connected to module. | ■ Reconnect the probe. |

# Pressure

## Directory of Keys



## Labels and Scales



# Pressure

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## Overview

A pressure key and waveform automatically display when you connect a pressure transducer to the module. The pressure key and waveform disappear from the display when you disconnect the pressure cable or transducer.

You can relabel the catheter site and/or zero the system any time the key and waveform are displayed. *Table 1* lists the available pressure key labels.

*Table 1: Pressure Label Definitions*

| Pressure Label | Description |
|---|---|
| ART | Arterial pressure |
| CVP | Central venous pressure |
| ICP | Intracranial pressure |
| LAP | Left atrial pressure |
| PA | Pulmonary artery pressure |
| RAP | Right atrial pressure |

*Table 1: Pressure Label Definitions*

| Pressure Label | Description |
|---|---|
| PRS | Generic pressure |
| UA | Umbilical artery pressure |
| UV | Umbilical vein pressure |

***Warning:***

***Systolic and diastolic pressures displayed numerically for patients being treated with an Intra-Aortic Balloon Pump (IABP) therapy may not be accurate. Display the waveform with scales to verify or determine pressures for these patients.***

Systolic, diastolic, and mean pressure values are displayed for arterial, pulmonary artery, umbilical artery, umbilical vein, and generic pressures. Only the mean value displays for other pressure types, except for ICP. Cerebral perfusion pressure (CPP) is computed as mean arterial pressure minus intracranial pressure (MAP-ICP) if ICP and at least one peripheral invasive arterial pressure are being monitored.

The message *CPP=???* appears if the system cannot compute the CPP value (for example, no mean arterial pressure is available).

***Note:***

*To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*

# Setting Up Pressure Monitoring and Zeroing the Transducer

Connect the cable end of a reusable or disposable transducer to the pressure connector located on the front of the module using a Spacelabs Healthcare pressure cable.

When setting up an invasive pressure system, take care to maintain system sterility and to prevent the introduction of air into the system. Air bubbles are the most common cause of inaccurate pressure readings. The transducer, stopcocks, connectors, and tubing must be completely free of air to ensure maximum performance.

***Note:***

- *Refer to the catheter, tubing, or transducer manufacturer's instructions or your hospital's protocol for specific instructions on removing air from the system.*
- *Invasive pressure systems specified by Spacelabs Healthcare are compatible with high-frequency electrosurgical and defibrillation equipment. No special precautions are required.*

If a *ZERO REJECTED* message appears after you have followed the instructions to zero the pressure transducer, follow the transducer manufacturer's directions to correct this problem before you continue.

**You must zero the system before you can begin monitoring. Zeroing has the following purposes:**

- Establishes atmospheric pressure as zero.
- Compensates for the hydrostatic effect of fluid in the catheter-tubing system.

**To select a pressure label:**

- Touch the pressure key displayed.
- Touch SELECT LABEL.
- Select the desired label.

**To zero the pressure transducer:**

- Position the stopcock close to the patient (at the phlebostatic axis).
- Touch the desired pressure parameter key.
- Open the stopcock to air and close the stopcock to the patient.
- Touch ZERO.
- Close the stopcock to air and open the stopcock to the patient.
- Begin monitoring after the pressure values appear.

# Display Detail

A pressure display appears once you select a pressure label and zero the transducer. *Figure 20-1* shows an example of the ART and ICP displays. The system identifies the specific pressure type in the parameter key and menu title (PA, CVP, LAP, etc.).

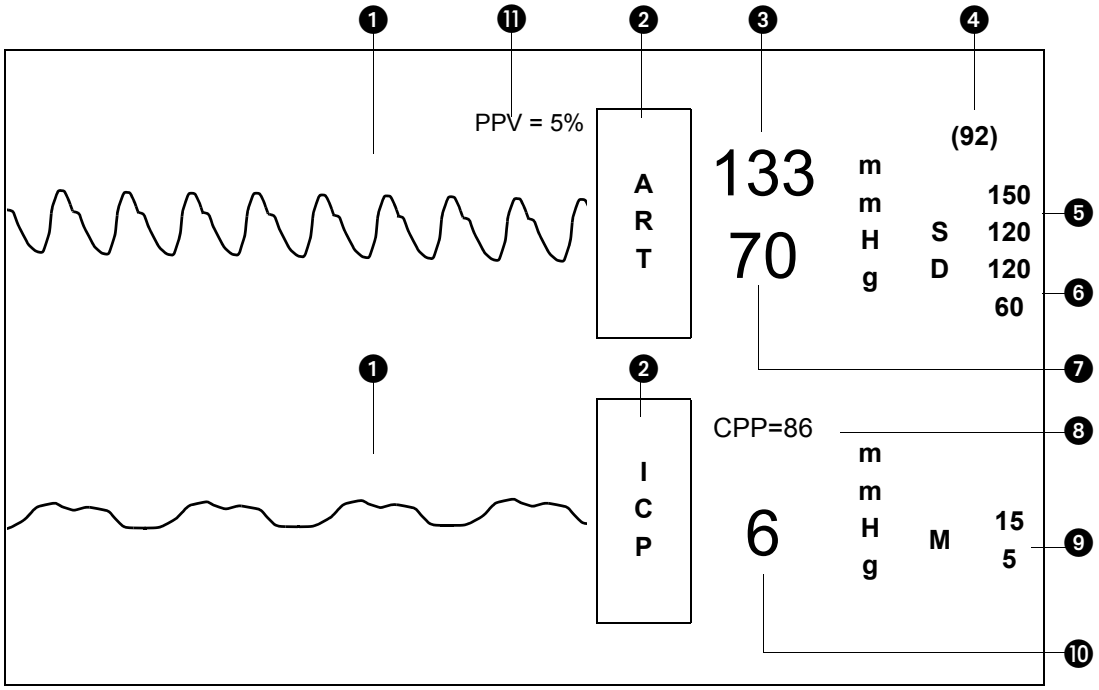



*Figure 20-1: Bedside pressure display*

1. Pressure waveforms
2. Pressure parameter keys
3. Systolic pressure
4. Mean pressure
5. Systolic pressure alarm limits
6. Diastolic pressure alarm limits
7. Diastolic pressure
8. Cerebral perfusion pressure (CPP)
9. Mean pressure alarm limits
10. Mean pressure
11. Pulse pressure variation (PPV)

## Selecting Numeric Display Size

You can select from three different display formats for pressure numeric data (for ART, PA, PRS, UA, and UV only). *Figure 20-2* provides examples of each of the three display formats. In each example, mean pressure is 92, systolic pressure is 133, and diastolic pressure is 70.

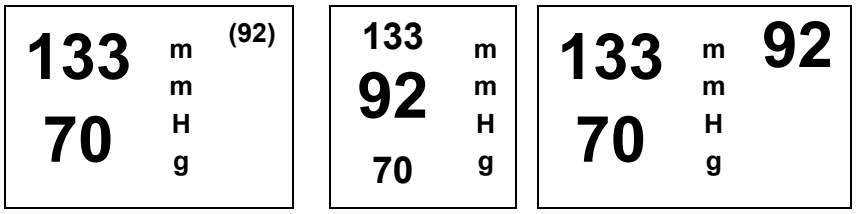



*Figure 20-2: Display formats*

***Note:***

*Specific alarm limits are not displayed in the All Large display format.*

**To change the numeric display size:**

- Touch the desired pressure parameter key.
- Touch SETUP.
- Touch NUMERIC SIZE.
- Select a display size.

# Enabling and Adjusting Alarms

You can set alarms for each pressure channel independently.

You can define systolic, diastolic, and mean value alarm limits for ART, PA, UA, UV, and PRS pressures.

The ICP **Alarm Limits** menu includes a cerebral perfusion pressure key (CPP) to set CPP alarm limits, along with keys for the mean limits.

Only the mean value alarm limits can be set for all other pressures.

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

**To set or adjust alarm limits:**

- Touch the desired pressure parameter key.
- Touch ALARM LIMITS.
- Select desired alarm.
- Select ALARM ON.
- Use the arrow keys to adjust.

# Adjusting Waveform Size and Sweep Speed

You can increase or decrease the size of the pressure waveform display without affecting the signal gain. The waveform size cannot be adjusted while the scales are displayed.

The sweep speed determines the rate at which the pressure waveform moves across the display.

**To change the waveform size:**

- Touch the desired pressure parameter key.
- Touch SIZE.
- Select SIZE ↑ or SIZE ↓.

**To select a pressure waveform sweep speed:**

- Touch the desired pressure parameter key.
- Touch SETUP.
- Touch SWEEP SPEED.
- Select a sweep speed or touch SAME AS ECG.

# Displaying Waveforms with Scales

You can superimpose a vertical reference scale over pressure waveforms. Up to four pressures can be scaled at one time.

Touch a parameter key and then the SCALES key to display scales when the pressure parameter key is activated. Select SCALES / ON to maintain the selected pressure display in scaled format until SCALES / OFF is selected.

You can freeze a pressure waveform display to stabilize the waveform for measurements. To unfreeze the waveform display, select FREEZE / OFF or exit the pressure menu by touching either the PREVIOUS MENU or NORMAL SCREEN keys.

***Note:***

*If you touch NORMAL SCREEN when the pressure scales overlay a multizone parameter, such as GAS, the pressure scales will disappear.*

You can increase or decrease the pressure waveform scale. The lowest scale value is always 0 (zero). Set the top of the scale to be any value from 10 to 500 mmHg by typing in the desired value and touching ENTER.

**To configure pressure waveform display with a vertical scale:**

- Touch the desired pressure parameter key.
- Touch SCALES.
- Select SCALES ON to maintain the pressure in scaled format.

**To freeze the pressure display:**

- Touch the desired pressure parameter key.
- Touch SCALES.
- Touch FREEZE / ON.

**To change the pressure waveform scale:**

- Touch the desired pressure parameter key.
- Touch SCALES.
- Touch SCALE 0-xxx.
- Type a new scale.
- Touch ENTER.

# Selecting the Waveform Measurement Value

You can obtain a measurement at any part of the pressure waveform using the horizontal cursor. The measurement value displays as *CURSOR = xx* in the message line above the **Pressure Scales** menu.

**Common uses of this function are:**

- Obtaining a pulmonary capillary wedge pressure (PCWP) value from the pulmonary artery catheter.
- Storing values in memory for later display using the Trend or Clinical Calculations features.

**To obtain a pulmonary capillary wedge pressure (PCWP):**

- Touch PA.
- Inflate the PA catheter balloon.
- Touch SCALES.
- Touch FREEZE / ON.
- Deflate the PA catheter balloon.
- Use the arrow keys to position the cursor.

**To store values in memory:**

- Touch the desired pressure parameter key.
- Touch SCALES.
- Use the arrow keys to position the cursor.

**For ART, PRS, UA, and UV:**

- Select SAVE SYS, SAVE DIA, or SAVE MEAN.

**For CVP, RAP, LAP, or ICP:**

- Touch SAVE MEAN.

**For PA:**

- Touch SAVE PCWP.

# Printing Pressure Waveforms

You can print pressure waveforms and values. Refer to *Printing* on page 9-5 for additional information.

***Note:***

*Do not change the pressure scales during a recording. This may lead to an annotation on the recording that does not match the actual scale of the recording.*

**To print pressure waveforms:**

- Touch RECORD.
- Touch the flashing pressure parameter key.

# Setting Artifact Rejection

Variations in intrathoracic pressures during the respiratory cycle can influence invasive pressures, especially PA, PCWP, and CVP. The respiratory artifact rejection feature minimizes the impact of such variations by automatically selecting data from waveform peaks that have little change in amplitude from peak to peak. End-expiration is typically the time with the least variation. The artifact rejection feature works equally well in both mechanically ventilated and spontaneously breathing patients.

In patients with chronic obstructive pulmonary disease, intrathoracic pressures during respiration are different than those in patients with normal lung function. Disable the artifact rejection feature when monitoring these patients.

**To activate respiration artifact rejection:**

- Touch the desired pressure parameter key.
- Touch SETUP.
- Select ART REJ / ON.

# Selecting a Filter Frequency

You can adjust the filter frequency to minimize the effect of noise and other interference that appears on the pressure waveform. The filter frequency can be set within the range of 3 to 40 Hz.

A higher filter frequency shows greater detail, but may also show more artifact. A lower filter frequency smooths the waveform and may help diagnose transducer or catheter problems, such as under-damping or ringing.

When the filter is set to 30 Hz or higher, the frequency response of the equipment is such that sinusoidal output pressure at 10 Hz is within 3 dB of the pressure reading at 1 Hz.

**To adjust the filter frequency:**

- Touch the desired pressure parameter key.
- Touch SETUP.
- Touch FILTER.
- Touch the arrow keys to choose the desired setting.

# Pulse Pressure Variation

Pulse pressure variation (PPV) can help clinicians to evaluate a patient's fluid volume status through the characterization of changes in the invasive pressure waveform in relation to respiration. Clinical studies have suggested that the greater the change that occurs with respiration, the more responsive the patient will be to fluid replacement therapy.

The PPV feature allows clinicians to freeze a pressure waveform and select the highest and lowest points of the largest and smallest pressure pulses. The largest and smallest pressure pulses coincide with the respiration cycle.

Pulse pressure variation is calculated with the following formula:

$$PPV\ (\%) = 100 \times [(P_{pmax} - P_{pmin}) / (P_{pmax} + P_{pmin})/2)]$$

where

$P_{pmax}$ = (Systolic – Diastolic) of the maximum pressure pulse; and

$P_{pmin}$ = (Systolic – Diastolic) of the minimum pressure pulse

**To calculate a pulse pressure variation (PPV):**

- Touch ART or PRS.
- Touch PPV.
- Touch FREEZE.
- Determine the largest pressure waveform on the display.
- Touch SYS MAX.
- Touch the arrow key to move the cursor to the highest point of the largest pressure waveform.
- Touch DIA MAX.
- Touch the arrow key to move the cursor to the lowest point of the largest pressure waveform.
- Determine the smallest pressure waveform on the display.
- Touch SYS MIN.
- Touch the arrow key to move the cursor to the highest point of the smallest pressure waveform.
- Touch DIA MIN.
- Touch the arrow key to move the cursor to the lowest point of the smallest pressure waveform.

**To store PPV values in memory:**

- Touch STORE PPV.

**To adjust PPV scales:**

- Touch ART or PRS.
- Touch PPV.
- Touch SCALES.
- Touch TOP OF SCALE or BOTTOM OF SCALE.
- Enter the desired scale value.
- Touch ENTER.

When using the arrow keys to adjust the cursor, touch and hold the key. The cursor moves in increments of 1 unit, then after 10 units, the cursor moves in increments of 5 units. After another 10 units, the cursor moves in increments of 10 units. Release the key to revert to moving the cursor in increments of 1 unit.

After selecting all pressure values for the maximum and minimum pulses, touch STORE PPV to calculate and store. Upon returning to the main display, the PPV value will be displayed in the pressure waveform zone for 10 minutes (refer to *Figure 20-1* on page 20-6). If an invalid combination of values are entered, the STORE PPV key is unavailable, displays **???**, and a message displays.

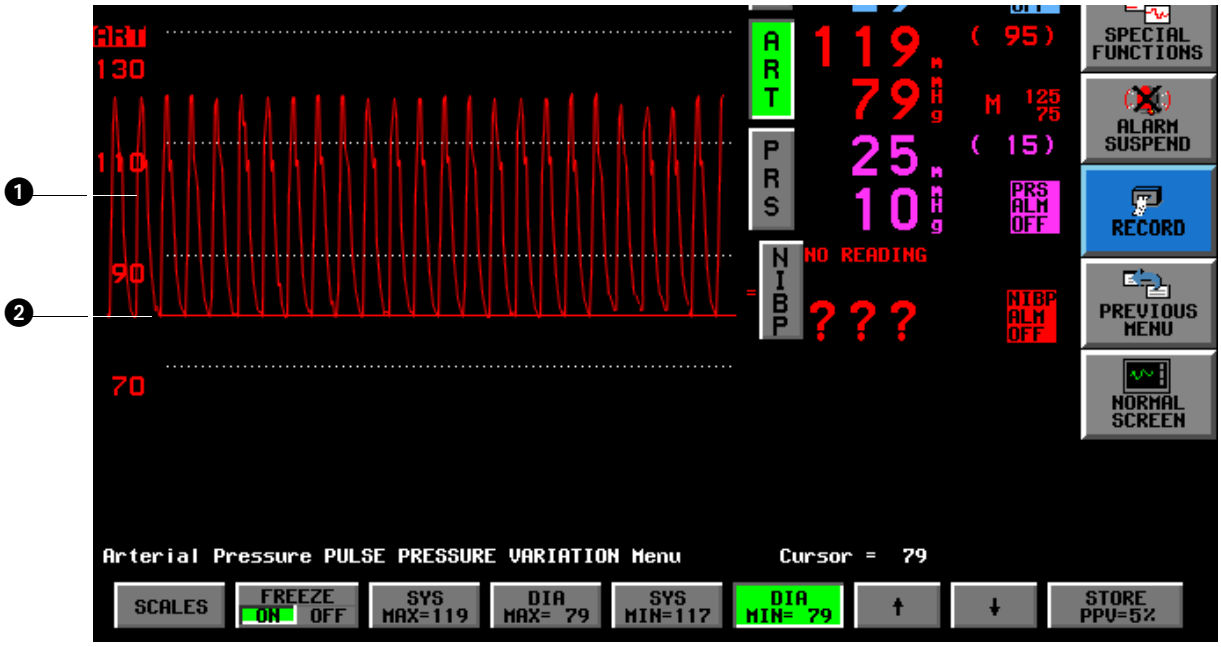



*Figure 20-3: PPV display*

1. Pressure scales
2. Measurement cursor

# Factory-Default Pressure Alarm Settings

*Table 2: Arterial (ART), Generic Pressure (PRS), Umbilical Artery and Vein (UA and UV), Cerebral Perfusion (CPP)*

| Systolic * | | |
|---|---|---|
| **mmHg** | **High** | **Low** |
| -50 to 79 | +30 | -05 |
| 80 to 109 | +30 | -10 |
| 110 to 119 | +30 | -15 |
| 120 to 129 | +25 | -20 |
| 130 to 139 | +20 | -20 |
| 140 to 149 | +15 | -20 |
| 150 to 159 | +10 | -20 |
| 160 to 169 | +10 | -25 |
| 170 to 179 | +10 | -30 |
| 180 to 189 | +10 | -35 |
| 190 to 300 | +10 | -40 |

| Systolic * | | |
|---|---|---|
| **kPa** | **High** | **Low** |
| -6.7 to 10.5 | +4.0 | -0.7 |
| 10.6 to 14.5 | +4.0 | -1.3 |
| 14.6 to 15.9 | +4.0 | -2.0 |
| 16.0 to 17.2 | +3.3 | -2.7 |
| 17.3 to 18.5 | +2.7 | -2.7 |
| 18.6 to 19.9 | +2.0 | -2.7 |
| 20.0 to 21.2 | +1.3 | -2.7 |
| 21.3 to 22.5 | +1.3 | -3.3 |
| 22.6 to 23.8 | +1.3 | -4.0 |
| 23.9 to 25.1 | +1.3 | -4.7 |
| 25.2 to 40.0 | +1.3 | -5.3 |

* *Example: If systolic is between 80 and 109 mmHg, the HI alarm defaults to 30 mmHg above the actual value and the LO alarm defaults to 10 mmHg below the actual value.*

| Diastolic | | |
|---|---|---|
| **mmHg** | **High** | **Low** |
| -50 to 69 | +30 | -05 |
| 70 to 79 | +20 | -10 |
| 80 to 89 | +20 | -15 |
| 90 to 99 | +15 | -15 |
| 100 to 109 | +10 | -20 |
| 110 to 119 | +05 | -25 |
| 120 to 300 | +05 | -30 |

| Diastolic | | |
|---|---|---|
| **kPa** | **High** | **Low** |
| -6.7 to 9.2 | +4.0 | -0.7 |
| 9.3 to 10.6 | +2.7 | -1.3 |
| 10.7 to 11.8 | +2.7 | -1.9 |
| 11.9 to 13.2 | +2.0 | -1.9 |
| 13.3 to 14.5 | +1.3 | -2.7 |
| 14.6 to 15.8 | +0.7 | -3.3 |
| 15.9 to 40 | +0.7 | -4.0 |

| Mean | | |
|---|---|---|
| **mmHg** | **High** | **Low** |
| -50 to 69 | +30 | -05 |
| 70 to 79 | +30 | -10 |
| 80 to 99 | +30 | -15 |
| 100 to 109 | +30 | -20 |
| 110 to 119 | +30 | -25 |
| 120 to 129 | +25 | -30 |
| 130 to 139 | +20 | -30 |
| 140 to 149 | +15 | -30 |
| 150 to 179 | +10 | -30 |
| 180 to 300 | +10 | -35 |

| Mean | | |
|---|---|---|
| **kPa** | **High** | **Low** |
| -6.7 to 9.2 | +4.0 | -0.7 |
| 9.3 to 10.5 | +4.0 | -1.3 |
| 10.6 to 13.2 | +4.0 | -2.0 |
| 13.3 to 14.5 | +4.0 | -2.7 |
| 14.6 to 15.8 | +4.0 | -3.3 |
| 15.9 to 17.2 | +3.3 | -4.0 |
| 17.3 to 18.5 | +2.7 | -4.0 |
| 18.6 to 19.8 | +2.0 | -4.0 |
| 19.9 to 23.8 | +1.3 | -4.0 |

*Table 3: Pulmonary Artery (PA), Right Atrial (RAP), Central Venous (CVP), Left Atrial (LAP), and Intracranial (ICP-mean) Only*

| Systolic, Diastolic, and Mean | | | | | |
|---|---|---|---|---|---|
| **mmHg** | **High** | **Low** | **kPa** | **High** | **Low** |
| -50 to 25 | +05 | -05 | -6.7 to 3.3 | +0.7 | -0.7 |
| 26 to 300 | +20% | -20% | 3.4 to 40 | +20% | -20% |

# IBP Alarm Delays

*Table 4: Invasive Pressure Alarms*

| Clinical Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Systolic High | -45 to 300 mmHg | Systolic change from 0 to 250 mmHg, limit 245 mmHg<br>Less than 13 seconds |
| Systolic Low | -50 to 295 mmHg | Systolic change from 250 to 0 mmHg, limit 5 mmHg<br>Less than 13 seconds |
| Diastolic High | -45 to 300 mmHg | Diastolic change from 0 to 250 mmHg, limit 245 mmHg<br>Less than 13 seconds |
| Diastolic Low | -50 to 295 mmHg | Diastolic change from 250 to 0 mmHg, limit 5 mmHg<br>Less than 13 seconds |
| Mean High | -45 to 300 mmHg | Mean change from 0 to 250 mmHg, limit 245 mmHg<br>Less than 13 seconds |
| Mean Low | -50 to 295 mmHg | Mean change from 250 to 0 mmHg, limit 5 mmHg<br>Less than 13 seconds |

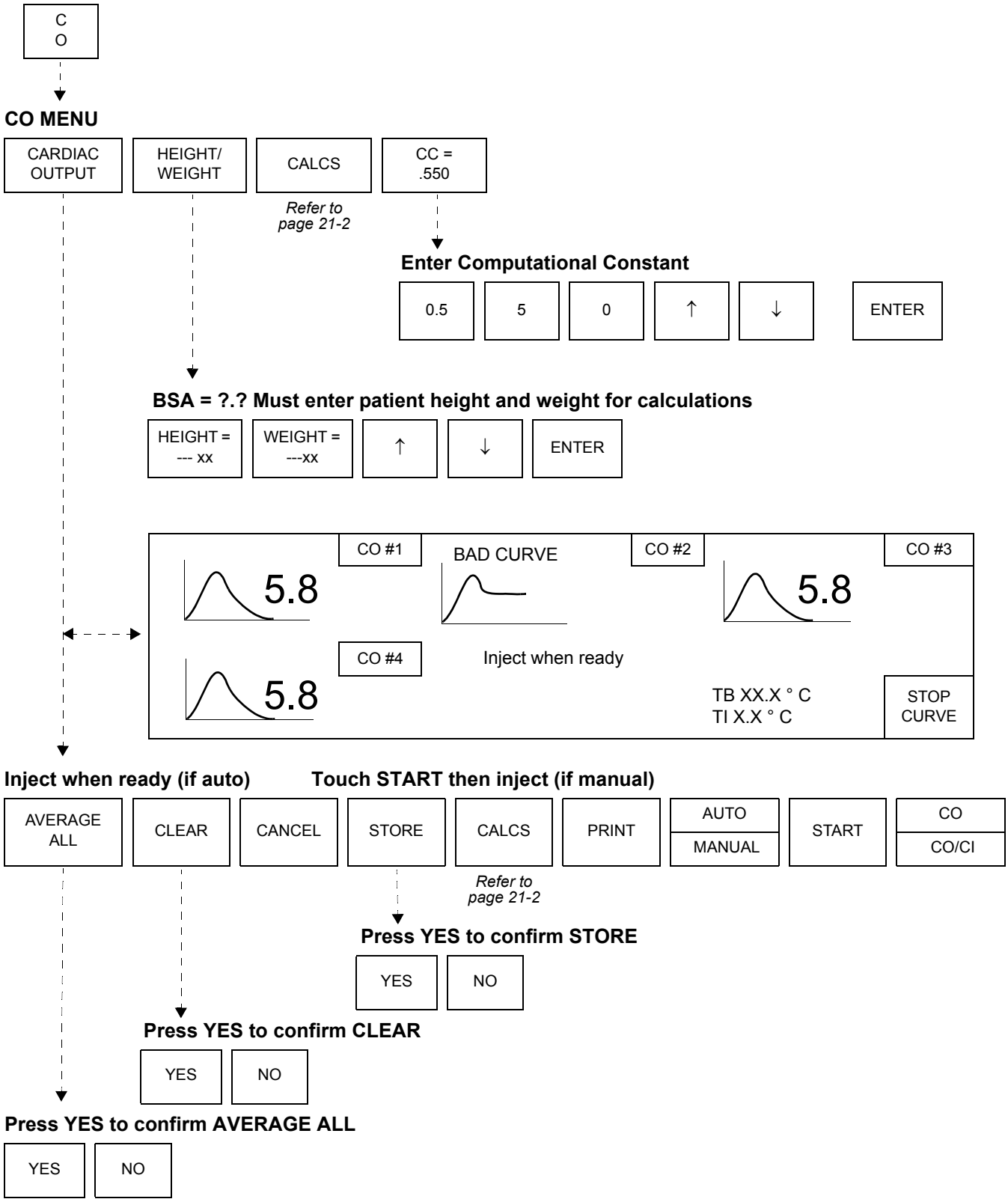
# Invasive Pressure Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Intermittent or no operation** | ■ Module error. | ■ Contact your biomed or a qualified field service engineer. |
| **No pressure key appears** | ■ Module not inserted correctly. | ■ Reinsert the module. |
| | ■ Transducer not connected. | ■ Reconnect the transducer. |
| **Numeric display is not stable** | ■ Respiration artifact too high. | ■ Select ART REJ / ON. |
| **Pressure display disappears** | ■ Cable disconnected from the module. | ■ Reconnect cable. |
| | ■ Cable disconnected from the transducer. | ■ Reconnect cable. |
| **Pressure shows NOT ZEROED** | ■ Pressure has not been zeroed. | ■ Zero the pressure with the ZERO key after opening transducer to air. |
| **Shows constant pressure** | ■ Stopcock(s) positioned incorrectly. | ■ Reposition stopcock(s) to connect the patient to the transducer (a waveform will appear on the display). |
| **ZERO REJECTED message appears** | ■ Stopcock(s) positioned incorrectly. | ■ Reposition stopcock(s) to open the transducer to air. Zero the pressure with the zero key. |
| | ■ Still unable to zero. | ■ Follow transducer manufacturer's instructions to correct the problem. |

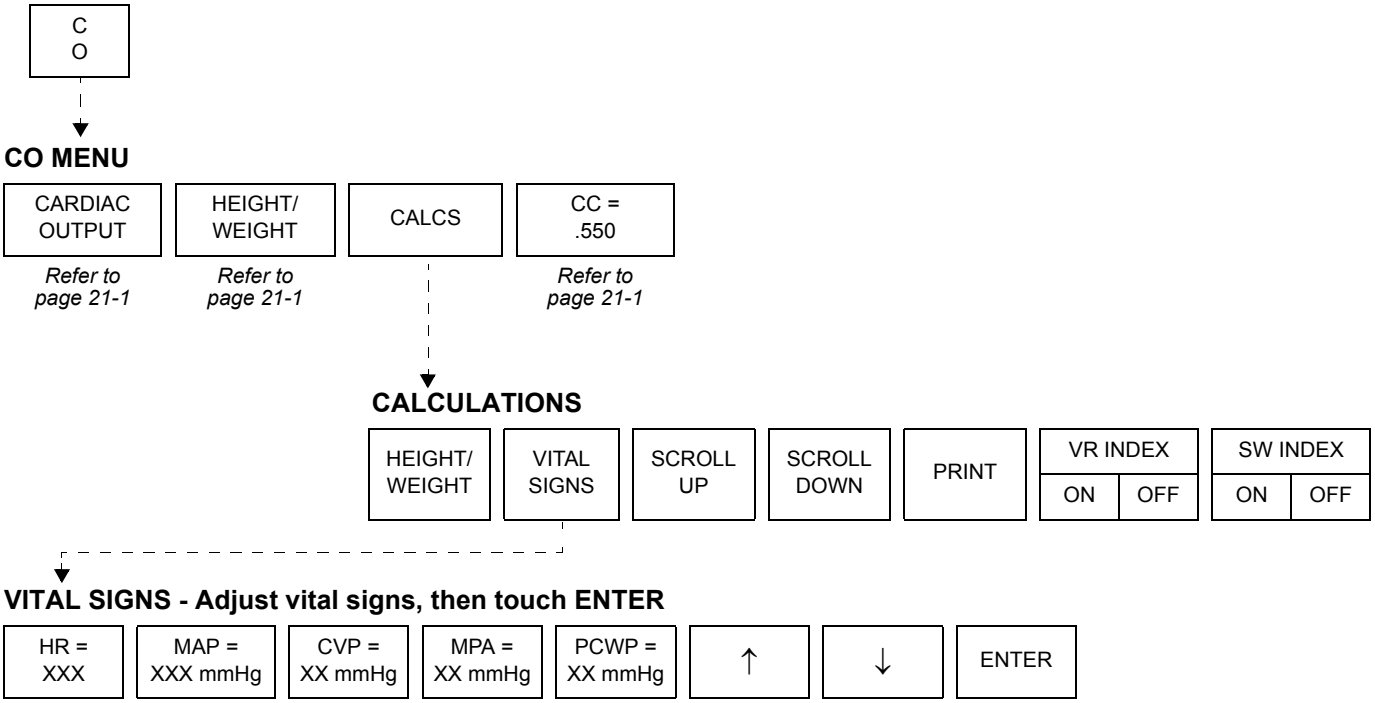
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **The SYS MAX value must be greater than the DIA MAX Value message appears** | ■ An invalid combination of values was entered for PPV. | ■ Select correct pressure values for the maximum pulses. |
| **The SYS MIN value must be greater than the DIA MIN value message appears** | ■ An invalid combination of values was entered for PPV. | ■ Select correct pressure values for the minimum pulses. |

# Cardiac Output

## Directory of Keys



# Calculations




| DAY/TIME | CO | CI | SV | SVI | SVR | PVR | LVSW | RVSW | HR | MAP | CVP | MPA | PCWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26/02:25p | 5.1 | 2.9 | 70.8 | 40.4 | 1629 | 235 | 54.9 | 10.4 | 72 | 110 | 6 | 25 | 10 |
| 27/09:30p | 4.9 | 2.8 | 65.3 | 37.8 | 1712 | 211 | 51.4 | 9.2 | 75 | 112 | 7 | 25 | 12 |
| 28/10:15p | 4.5 | 2.5 | 56.2 | 32.1 | 1917 | 213 | 44.5 | 7.8 | 80 | 115 | 7 | 25 | 13 |
| 29/07:30a | 4.0 | 2.2 | 47.0 | 26.8 | 2237 | 219 | 38.2 | 6.5 | 85 | 120 | 8 | 26 | 15 |
| 30/08:30a | 4.0 | 2.2 | 47.0 | 26.8 | 2237 | 219 | 38.2 | 6.5 | 85 | 120 | 8 | 26 | 15 |

*Select a row of data by pressing the key corresponding to the day/time desired*

# Cardiac Output

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Setting Up Cardiac Output Monitoring . . . 4
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Entering Patient Height/Weight . . . 7
Measuring Cardiac Output . . . 7
Averaging Cardiac Output . . . 8
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## Overview

Cardiac output (CO) monitoring enables you to evaluate the patient's fluid status and the pumping ability of the heart. It also calculates and displays various hemodynamic values. Cardiac output is calculated by the thermodilution technique, using a variation of the Stewart-Hamilton formula. Thermodilution involves injecting a cooled or room temperature fluid (injectate) through a flow-through housing and into an intravascular catheter. The catheter delivers the injectate directly to the right atrium. It monitors the temperature downstream from the delivery site at the pulmonary artery.

Cardiac output is determined by measuring the change in blood temperature downstream from the delivery site with respect to time. The change in temperature is inversely proportional to the flow of blood through the right heart. If the flow is large, the volume of blood that the injectate mixes with is also large, so the monitor detects a small change in temperature. When a smaller flow of blood is diluted by the same volume of injectate (as in the pulmonary artery), the change in temperature is larger.

The system displays cardiac output by acquiring a curve for each injection. The vertical axis of the curve represents temperature, and the horizontal axis represents time.

Vital sign values are automatically captured at the moment each CO curve is completed. This information is used to produce hemodynamic calculations.

# Setting Up Cardiac Output Monitoring

The following setup procedure assumes that the pulmonary artery catheter has been properly placed in the patient. *Figure 21-1* illustrates the components used for CO monitoring.

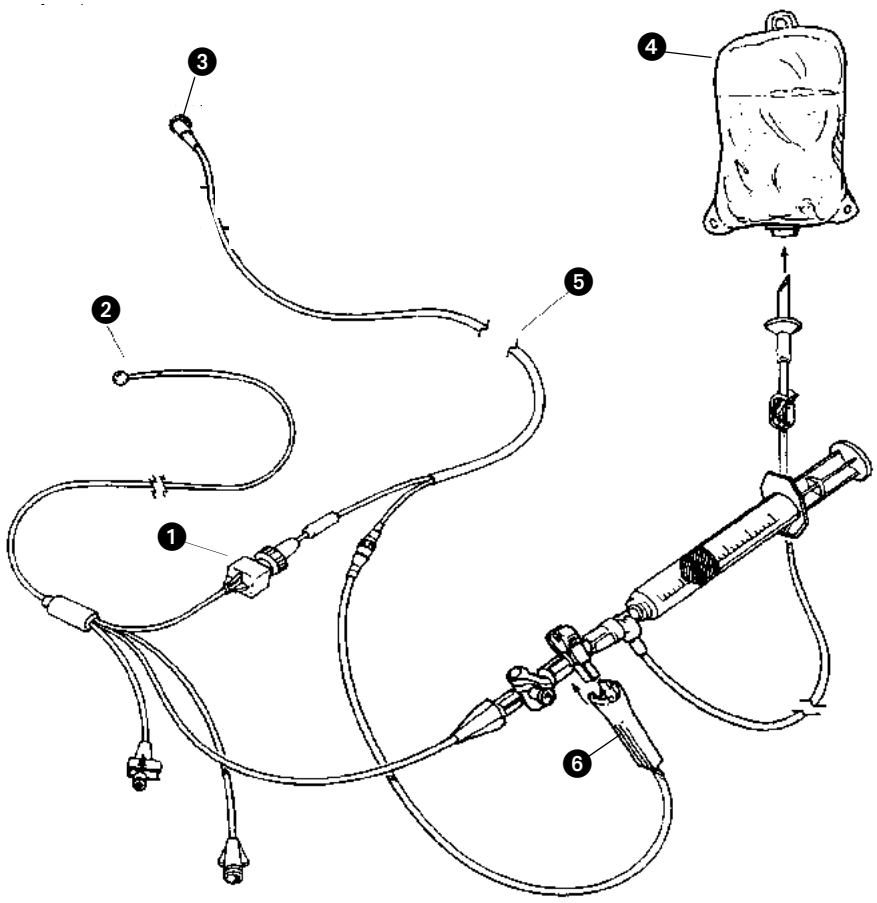



*Figure 21-1: Cardiac output monitoring setup*

1. Thermistor connector
2. Thermodilution catheter
3. Module connection
4. Injectate
5. Cardiac output cable
6. In-line injectate temperature probe

**To set up cardiac output monitoring:**

- Insert the cardiac output cable into the module.
- Attach the thermodilution catheter to the cardiac output cable.
- Connect either an in-line injectate temperature probe or a reference solution injectate probe to the cardiac output cable.

When using a reference solution injectate temperature probe, it should be inserted into the cardiac output cable in place of the in-line injectate temperature probe.

# Display Detail

The CO key appears once you connect the cardiac output cable to the module. To display the **CO** menu, touch the CO key.

When you connect the thermistor connector port of the catheter to the cardiac output cable, the patient's blood temperature (TB) value displays. When you connect the injectate temperature probe, the temperature of the injectate (TI) displays, but the information is not trended. A message appears, instructing you to connect the probe or catheter or to enter the computational constant (CC).

If you connect the cardiac output cable only to the catheter or only to the injectate probe, you can enter or adjust the computational constant, but you cannot monitor cardiac output.

The message *Touch START then inject* appears if you select MANUAL mode. The message *Inject when ready appears* when the system is ready to acquire a new output curve (if AUTO mode is selected. Curves appear as the system detects the flow for each injection. Five curves can be displayed at one time. *Figure 21-2* illustrates the cardiac output display on a bedside monitor when curves are being acquired.

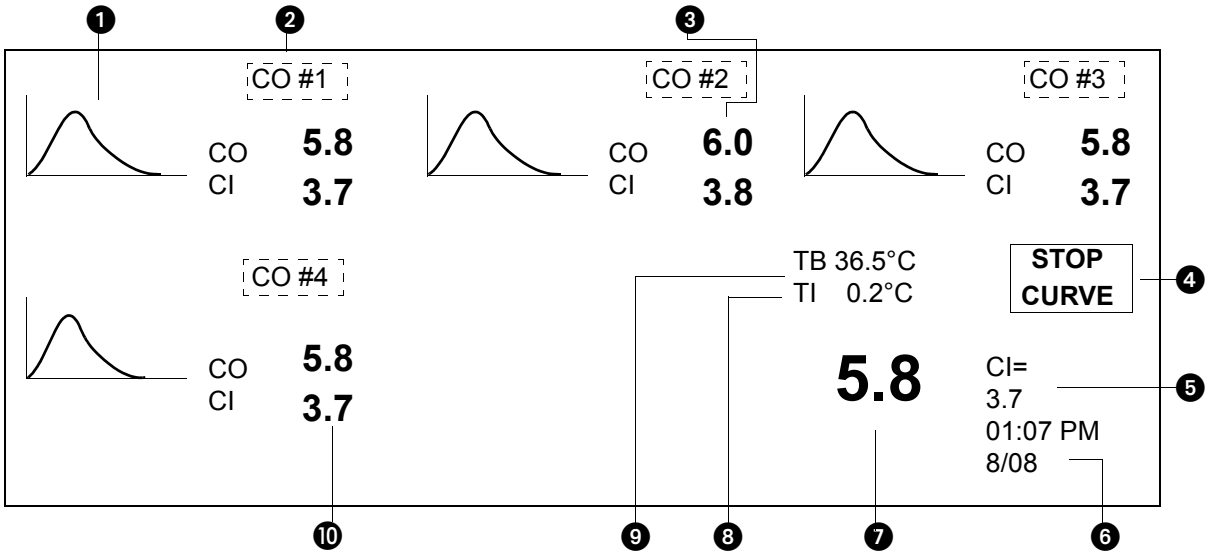



*Figure 21-2: Bedside monitor*

❶ Cardiac output curve

❷ Curve ID number key (used to select a curve) (ranges from 1 to 99)

❸ Cardiac output value (liters/minute)

❹ STOP CURVE key (only appears during curve drawing)

❺ Cardiac index value (average) (only appears if CI was calculated when CO was acquired)

❻ Time and date of averaging

❼ Cardiac output value (average)

❽ Injectate temperature

❾ Blood temperature

❿ Cardiac index value

## Displaying Cardiac Output and Cardiac Index Values

The cardiac output value, or both cardiac output and cardiac index values, can be displayed with the curves. If the CO portion of the CO / CO/CI key is selected, only the cardiac output value appears. To display both the cardiac output and cardiac index values, select the CO/CI segment of the key.

**To display both cardiac output and cardiac index values with the curves:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch CO / CO/CI.

# Entering the Computational Constant

To acquire cardiac output data, you must first enter the computational constant (CC) and verify that the system is correctly configured.

The injectate temperature changes because of contact with the catheter wall and the surrounding blood. To account for this interaction, the system includes a correction factor in the equation. The correction factor (K or CT) is a function of the catheter and the dimensions of the flow-through housing, internal volume, and injectate temperature. The correction factor differs among catheter models and manufacturers. Refer to your thermodilution catheter package insert for the CC value.

Once you enter a value for the computational constant, the value appears on the CC= key and remains in the system's memory. The message *CC REQUIRED* appears until you enter the computational constant.

**To enter the computational constant:**

- Touch CO.
- Touch CC=.
- Touch the appropriate keys (tenths, hundredths, and then thousandths) and use the arrow keys to adjust.
- Touch ENTER.

# Entering Patient Height/Weight

To perform indexed hemodynamic calculations, you must enter the patient's height and weight before you generate CO curves. CO uses the patient's height and weight entered during admission (refer to *Entering Height, Weight, and Body Surface Area (BSA)* on page 8-6). The valid range for height is from 8 to 84 inches (20 to 215 cm). The valid range for weight is from 2 to 551 pounds (1 to 250 kg). After you enter both height and weight values, the system automatically calculates and displays the patient's body surface area (BSA).

**To enter patient height and weight:**

- Touch CO.
- Touch HEIGHT/WEIGHT.
- Select HEIGHT = or WEIGHT =.
- Use the arrow keys to adjust.
- Touch ENTER.

# Measuring Cardiac Output

Allow the catheter to warm up between injections to maintain the accuracy of the readings. Once the blood temperature is stable, the *INJECT WHEN READY* message appears (AUTO mode) or the *TOUCH START THEN INJECT* message appears (MANUAL mode).

The STOP CURVE key that appears during data acquisition enables you to stop acquiring and drawing the cardiac output curve. Touching this key invalidates all curve data for that injection.

**To obtain CO measurements:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Select AUTO or MANUAL.
- Wait for the *INJECT WHEN READY* or the *TOUCH START THEN INJECT* message to appear.
- Touch START (in MANUAL mode).
- Inject the prepared injectate into the proximal lumen of the thermodilution catheter.

**To stop a curve in progress, touch STOP CURVE.**

Some curves may automatically be classified as “bad,” in which case they are labeled BAD CURVE.

**There are a number of possible causes for bad curves:**

- Unsteady baseline
- Irregular curve from shunts or poor injection
- Delayed curve
- Catheter or probe fault during curve acquisition

If a bad curve is displayed when you select to average, store, or clear another displayed curve, the bad curve is also cleared. Delete bad curves as necessary to acquire additional curves.

***Note:***

*To obtain all hemodynamic calculations, remember to enter height and weight, and to store a PCWP prior to initiating a measurement of CO.*

A 15-minute timer begins after acquisition of the first good curve. After 15 minutes, the AUTO/MANUAL and START keys become unavailable, and the message *MUST SELECT CURVES*, *AVERAGE*, *STORE*, or *CLEAR CO* appear. Cardiac output injections are disabled until you perform one of these actions. Injections may resume as soon as the *INJECT WHEN READY* or *TOUCH START THEN INJECT* message appears.

# Averaging Cardiac Output

This function computes the average using the data from up to five good, displayed curves. Curves labeled as bad curves are not included in the average. You can perform cardiac output averaging as soon as the system has measured and displayed at least two good curves.

**When the averaging is complete, the CO zone displays the following:**

- Curves used in the average
- Averaged cardiac output and cardiac index values
- Time and date of the last curve

**To average all cardiac output curves:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch AVERAGE ALL.
- Touch YES.

# Clearing and Storing Cardiac Output Curves

Occasionally you may want to delete a curve prior to averaging or storing. All curves, or only selected curves, can be cleared. When you clear an individual CO curve or all CO curves, the *Inject when ready* message appears in the first available curve position, so the curves displayed on the display may not appear in numerical order.

The Store feature enables you to store all acceptable, displayed curves at once or individually. The system stores the vital signs and cardiac output values acquired at the end of curve acquisition, along with the time it displayed each curve. The curves clear from the display as they are stored. After you store the acceptable curves, the system clears all curves from the display.

**To clear or store selected curves:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch the CO# key(s) adjacent to the curve(s) (up to five) that you wish to clear or store.
- Select CLEAR or STORE.
- Touch YES.

**To clear or store all curves:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Select CLEAR or STORE.
- Touch YES.

# Calculations Table

You can view the hemodynamic calculations table after storing or averaging data. The table includes only those calculations that have been stored or averaged.

The system uses the BSA to normalize the values. Cardiac Index (CI) and Stroke Volume Index (SVI) values are automatically displayed. You can choose to display either the Systemic Vascular Resistance (SVR) and Pulmonary Vascular Resistance (PVR) values, or their indexed values (SVRI and PVRI), but not both simultaneously. You can also choose to display either the Left Ventricular Stroke Work (LVSW) and Right Ventricular Stroke Work (RVSW) values, or their indexed values (LVSWI and RVSWI), but not both simultaneously.

**To display the calculations table:**

- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).

**To select indexing:**

- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Select VR INDEX / ON or SW INDEX / ON.

**To view additional sets of data:**

- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Touch SCROLL UP to scroll the data up one row, touch SCROLL DOWN to scroll the data down one row.

*Table 1* shows an example of the hemodynamic calculations table that appears when you touch the CALCS key. Each row is one complete set of data. Each new value appears in a new row at the bottom of the table. Five sets of data are displayed at any one time. Additional sets of values can be displayed by scrolling through the data. Thirty sets of values are saved in the monitor's hemodynamic calculations table, so you can remove and re-insert the module without losing hemodynamic values. You can erase these values by discharging a patient or by powering the monitor OFF.

***Note:***

*The vital sign values shown in Table 1 are typical if your monitor's UNITS OF MEASURE key is set to mmHg.*

*Table 1: Sample Hemodynamic Calculations Table*

| DAY/TIME | CO | CI | SV | SVI | SVR | PVR | LVSW | RVSW | HR | MAP | CVP | MPA | PCWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26/02:25p | 5.1 | 2.9 | 70.8 | 40.4 | 1629 | 235 | 54.9 | 10.4 | 72 | 110 | 6 | 25 | 10 |
| 26/09:30p | 4.9 | 2.8 | 65.3 | 37.8 | 1712 | 211 | 51.4 | 9.2 | 75 | 112 | 7 | 25 | 12 |
| 26/10:15p | 4.5 | 2.5 | 56.2 | 32.1 | 1917 | 213 | 44.5 | 7.8 | 80 | 115 | 7 | 25 | 13 |
| 27/07:30a | 4.0 | 2.2 | 47.0 | 26.8 | 2237 | 219 | 38.2 | 6.5 | 85 | 120 | 8 | 26 | 15 |
| 27/08:30a | 4.0 | 2.2 | 47.0 | 26.8 | 2237 | 219 | 38.2 | 6.5 | 85 | 120 | 8 | 26 | 15 |

Day/Time

Calculated Values

Vital Signs Values

The system automatically calculates and enters CO and CI values in the table. Values in the SV, SVI, SVR, PVR, LVSW, and RVSW columns are automatically calculated from the vital sign values displayed in the HR, MAP, CVP, MPA, and PCWP columns.

The values in the HR, MAP, CVP, MPA, and PCWP columns are parameter values obtained from other parameters in the bedside monitor at the time a CO value is calculated, or values that were manually entered (refer to *Editing Vital Sign Values* on page 21-12).

A CVP value is used in calculations, if it is available. If a CVP value is not available, the RAP value is used in place of CVP. If neither CVP nor RAP pressure is available, the system cannot automatically calculate SVR, SVRI, RVSW, or RVSWI.

***Note:***

*To ensure that a RAP/CVP value can be obtained, immediately reopen the stopcock to the patient after you inject the bolus, so that flow is reinstated.*

A PCWP value is used in calculations if the PCWP value was stored within the last 15 minutes. If no such PCWP value is present, an LAP value is substituted. If neither PCWP nor LAP values are available, the system cannot automatically calculate PVR, PVRI, LVSW, or LVSWI, and the message *NO PCWP VALUE AVAILABLE WITHIN THE LAST 15 MINUTES* appears on the monitor when that curve is acquired.

If you do not enter height and weight values prior to generating CO curves, the monitor displays any value that uses BSA (e.g., CI, SVI, LVSWI, and RVSWI) as **?.?**. If a calculated value is out of the displayable range, the monitor displays the value as **++++**. The system uses the value 0 (zero) in the calculations if any of the vital signs in the hemodynamics table are negative.

*Table 2* lists the equations used for the hemodynamics table (assumes that pressures are measured in mmHg). Pressure values measured in kPa are automatically converted to mmHg prior to calculation.

*Table 2: Hemodynamic Equations*

| | |
|---|---|
| **BSA** | = $Ht^{0.725} \times Wt^{0.425} \times 0.007184$ |
| **CI** | = CO/BSA |
| **SV** | = (CO/HR) × 1000 |
| **SVI** | = SV/BSA |
| **SVR** | = 79.9 × [(MAP-CVP)/CO] |
| **SVRI** | = 79.9 × [(MAP-CVP)/CI]<br>= 79.9 × [(MAP-CVP)]/[CO/BSA]<br>= 79.9 × [(MAP-CVP)]/[CO × 1/BSA]<br>= 79.9 × [(MAP-CVP)/CO] × BSA<br>= SVR × BSA |
| **PVR** | = 79.9 × [(MPA-PCWP)/CO] |
| **PVRI** | = 79.9 × [(MPA-PCWP)/CI]<br>= 79.9 × [(MPA-PCWP)]/[CO/BSA]<br>= 79.9 × [(MPA-PCWP)]/[CO × 1/BSA]<br>= 79.9 × [(MPA-PCWP)/CO] × BSA<br>= PVR × BSA |
| **LVSW** | = 0.0136 × SV × (MAP – PCWP) |
| **RVSW** | = 0.0136 × SV × (MPA – CVP) |
| **LVSWI** | = LVSW / BSA |
| **RVSWI** | = RVSW / BSA |

## Editing Vital Sign Values

**To edit vital sign values:**

- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Touch DAY/TIME in the row you wish to select.
- Touch VITAL SIGNS.
- Select the vital sign you wish to edit.
- Use the arrow keys to edit the displayed value.
- Touch ENTER.

*Table 3: Hemodynamic and Vital Sign Values*

| Label | Name | Units | Default Value | Valid Range |
|---|---|---|---|---|
| HR | Heart Rate | bpm | 70 | 0 to 300 |
| MAP | Mean Arterial Pressure | mmHg<br>kPa | 80<br>10.7 | 0 to 300<br>0 to 40 |
| CVP | Central Venous Pressure | mmHg<br>kPa | 10<br>1.3 | 0 to 99<br>0 to 13.2 |
| MPA | Mean Pulmonary Artery Pressure | mmHg<br>kPa | 15<br>2 | 0 to 99<br>0 to 13.2 |
| PCWP | Pulmonary Capillary Wedge Pressure | mmHg<br>kPa | 10<br>1.3 | 0 to 99<br>0 to 13.2 |

Default values are supplied if you touch the VITAL SIGNS key and no prior value is available. When you edit a value, the system recalculates the hemodynamic calculation values using the new vital sign value.

# Printing Cardiac Output Curves

**You can print cardiac output data in the following formats:**

- All curves in the CO display area
- The portion of the displayed calculations table

**To print thermodilution curves:**

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch PRINT.

**To print the CO table:**

- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Touch PRINT.

# Cables and Probes

Refer to the Spacelabs Healthcare Supplies Products catalog for part numbers and specifications for cables, probes, and injectate systems.

## Computational Constants/Catheter Compatibility

**Nominal resistance @ 37° C 14,004 Ω ±15%**

Refer to the instructions provided with your catheter for the computational constants for your specific catheter, setup, injectate temperature, and injectate volume. Contact your thermodilution catheter sales representative for additional information.

***Warning:***

***For 3 cc injectate volumes, a 0° to 5° C injectate temperature is required for consistent results.***

***Note:***

*The cardiac output function is compatible with the Baxter Edwards Critical-Care REF and REF-Ox catheters for cardiac output measurement, but cannot perform the REF function.*

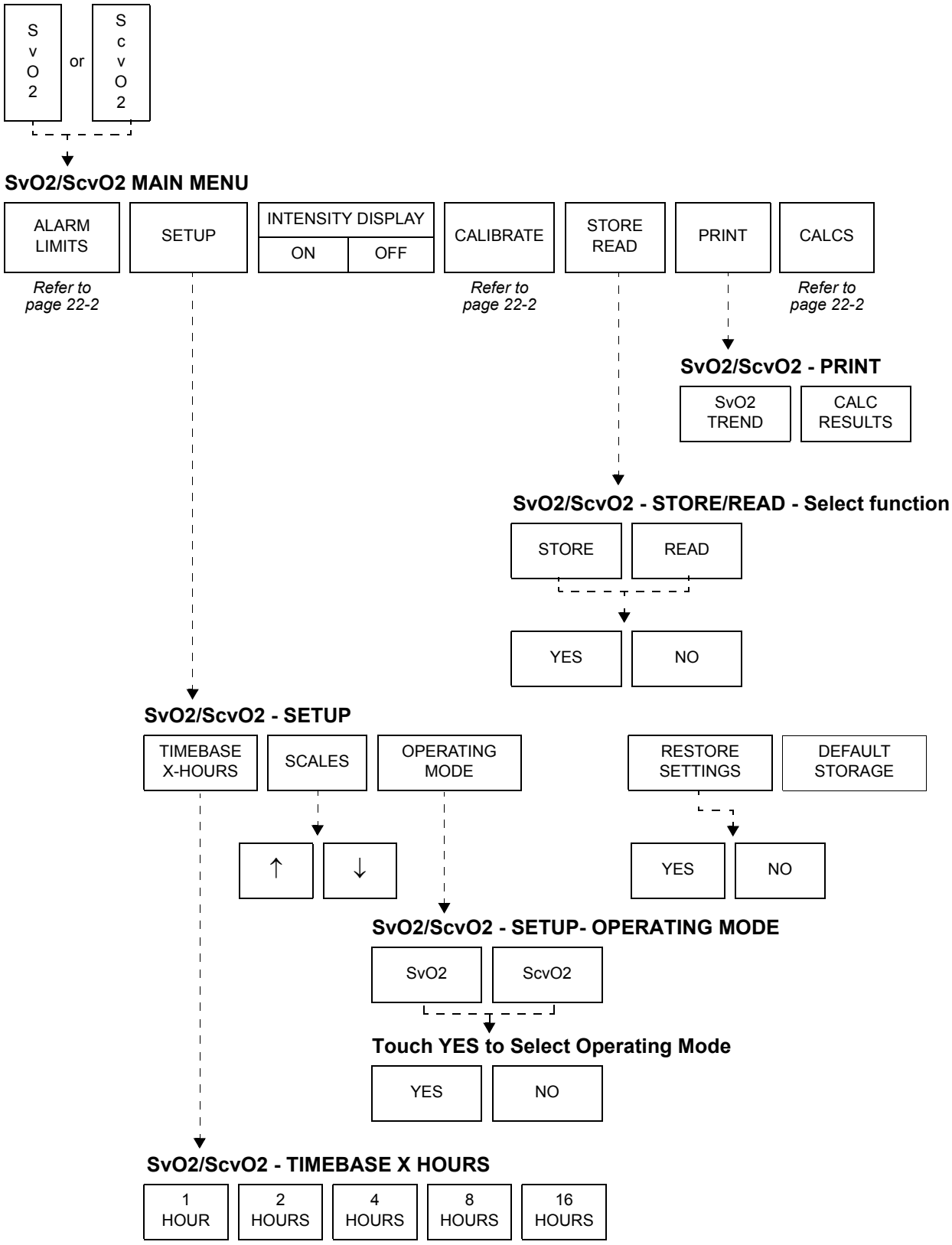
# Cardiac Output Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Unable to acquire CO data** | ■ There is a problem with the thermodilution catheter (*CATHETER FAULT* message appears). | ■ Connect or replace the catheter. |
| | ■ There is a problem with the probe (*PROBE FAULT* message appears). | ■ Connect or replace the probe. |
| | ■ Computational constant not entered. | ■ Enter computational constant. |
| **Invalid pressure reading** | ■ Stopcock of the CVP or RAP line may not have been turned OFF quickly enough after injection was made. | ■ Turn the stopcock off immediately after making the injection to provide the module with the correct pressure value at the time it obtains the curve. |
| **Erroneous CO values using room temperature injectate** | ■ Injectate is too warm (above 25.5° C) — *TI TOO WARM* message appears. | ■ Lower the injectate temperature. |
| | ■ Injection rate is too slow. | ■ Administer bolus smoothly at a rate of ≤10 cc/4 seconds. |
| **Unable to obtain indexed values for calcs** | ■ Did not enter height and/or weight prior to averaging curves. | ■ Enter the height/weight and reinject the curves. |
| | | ■ Enter the height/weight in hemo calcs to obtain index values for previously acquired curves. |
| **Value of calcs variable displays as +++** | ■ Measured value is out of range. | ■ Check vital sign and height/weight values for validity. |

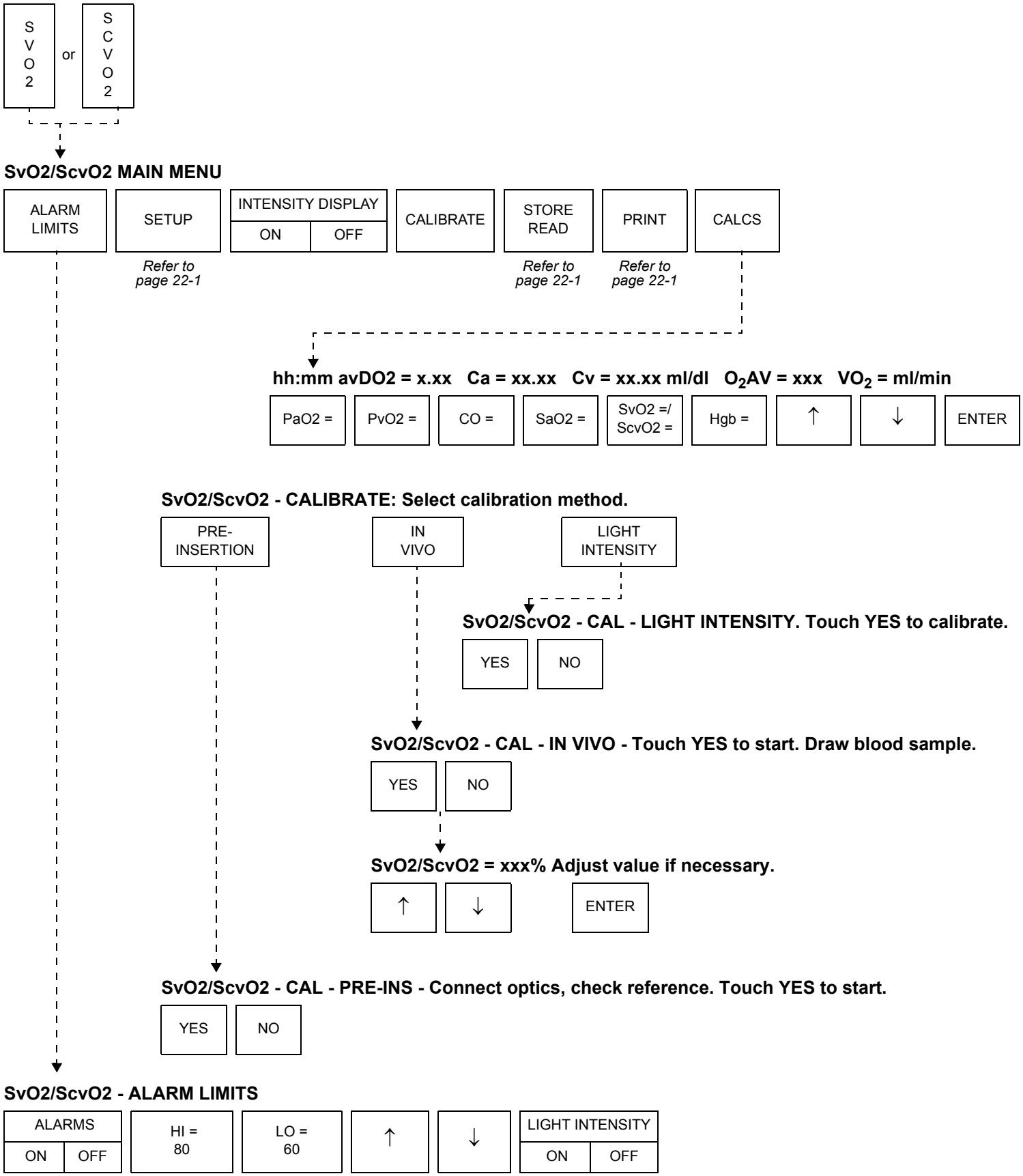
| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Spontaneous CO curves drawn while in AUTO mode** | ■ Infusion of IV drips or medications through the proximal port. | ■ Turn off the IV solutions temporarily. |
| | ■ Mechanically ventilated patient is causing shifts in PA temperature. | ■ Use the MANUAL mode. |
| | ■ Cardiac arrhythmias are causing blood flow variance. | ■ Use the MANUAL mode and time the injection during stable ECG rhythm. |
| **Substantial variance in CO values/irregular curves** | ■ Varied temperature in the bolus. | ■ Standardize the temperature of the bolus. |
| | ■ Injection is being delivered at varying points in the respiratory cycle. | ■ Use the MANUAL mode and time the injection at end-expiration, if desired. |
| | ■ Blood temperature is unacceptable (*TB OUT OF RANGE* message appears). | ■ The temperature must be between 17.2° and 43° C. |
| | ■ The temperature difference between the injectate and body is less than 8° C (*TEMPERATURE ERROR* message appears). | ■ Lower the injectate temperature. |
| | ■ Movement. | ■ Standardize the patient position during procedure. |
| | ■ Physiological problems. | ■ Any of the following conditions can affect accurate readings: ventricular arrhythmias, low stroke volume, and/or valve insufficiency. |
| | ■ Injectate rate is too slow. | ■ Administer the bolus smoothly at a consistent rate. |
| **No curve drawn after bolus injected** | ■ Insufficient time has elapsed between injections to allow blood temperature stabilization. | ■ Wait 60 to 90 seconds between injections. |

# $SvO_2/ScvO_2$

## Directory of Keys



## Intensity Display, Calibration, and Calcs



# $SvO_2/ScvO_2$

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## Overview

Measurements of mixed venous oxygen saturation ($SvO_2$) or central venous oxygen saturation ($ScvO_2$) provides a status indicator of the oxygen transport system in critically ill patients. Low or rapidly decreasing saturation values indicate an imbalance between oxygen consumption and oxygen delivery. Normal values reflect a balance of the oxygen transport system, or the patient's ability to successfully compensate for alterations in oxygen supply or demand. Continuous $SvO_2/ScvO_2$ monitoring can reduce the frequency of additional invasive measurements and enhance the timeliness of intervention in critically ill patients.

$SvO_2$ monitoring requires the insertion of a pulmonary artery (PA) catheter. As a less invasive alternative, $ScvO_2$ provides monitoring of oxyhemoglobin saturation in the central venous system. $ScvO_2$ requires the insertion of a central venous catheter.

## Indications for Use

The Spacelabs Healthcare $SvO_2/ScvO_2$ Module is intended to be used with the Hospira optical module and OPTICATH oximetry catheters and probes for the continuous, in vivo measurement of the oxyhemoglobin saturation of blood for monitoring hemodynamic status during metabolic, respiratory, cardiovascular, and/or other physiological system(s) compromise, in accordance with hospital protocols or current clinical standards of practice.

# Introduction

This system uses three-wavelength reflectance spectrophotometry to sense the amount of light absorbed by the blood. The use of three wavelengths compensates for changes in light reflectance from red blood cell surfaces and blood vessel walls and for variations in hematocrit values. Digital filtering reduces vessel-wall artifacts.

Data acquisition begins when a Hospira oximetry catheter is positioned within the pulmonary artery. The catheter connects to a Hospira optical module containing three LEDs, which emit red and infrared wavelengths of light. The catheter returns reflected light through a second optical fiber to the optical module. Here the light is converted to an electrical signal, which the system recognizes and displays as a saturated venous oximetry value (percent $SvO_2/ScvO_2$).

The $SvO_2/ScvO_2$ module performs constant memory checks to ensure information is not lost or changed erroneously. When the *OPTICAL MODULE MEMORY ERROR* message appears, replace the optical module with a known good unit.

When you disconnect the optical module from the $SvO_2/ScvO_2$ module, $SvO_2/ScvO_2$ monitoring is suspended and the *NO OPTICAL MODULE* message appears. If this message appears when the optical module is not disconnected, replace the optical module or contact a qualified field service engineer.

**Caution:**

- **The Spacelabs Healthcare $SvO_2/ScvO_2$ module requires the use of a Hospira optical module and Hospira oximetry catheter. Both items must be acquired directly from a Hospira representative. Refer to www.hospira.com for more information.**
- **The Hospira optical module provides patient isolation from the monitor system. Refer to Hospira accompanying documents for instructions on cleaning and maintenance.**
- **The Spacelabs Healthcare $SvO_2/ScvO_2$ module will not operate correctly with any other catheter for $SvO_2/ScvO_2$ monitoring.**

# Display Detail

*Figure 22-1* provides an example of a trend of venous oximetry values and the current light intensity value on a bedside monitor.

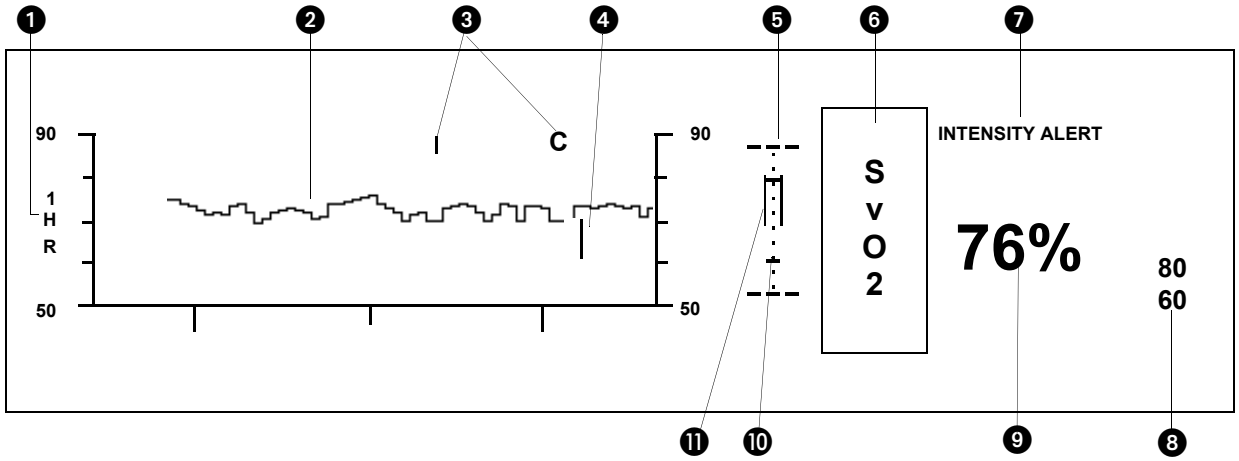



*Figure 22-1: Bedside monitor*

1. Current time base
2. Venous oximetry trend graph
3. Event marks
4. Light intensity display mark (vertical lines) superimposed over the trend graph
5. Light intensity bar graph (light meter)
6. SvO2/ScvO2 parameter key (depends on user selection)
7. Status or error message area
8. Current alarm limits
9. Current venous oximetry value
10. Markers for normal intensity levels (two horizontal lines)
11. Real time intensity signal level (two vertical lines)

The most recent minute of mixed venous oxygen saturation data displays as a point on the right side of the trend graph. As the module acquires new data, the older data points move left to create a record of data.

## Event Marks

The system automatically displays event marks along the top of the trend graph to note the point when any of the following events occur:

**P** — Pre-insertion calibration initiated

**I** — In vivo calibration initiated

**C** — In vivo calibration complete

**L** — Light intensity calibration complete

**F** — Calibration failure

**R** — Light intensity range error

## Displaying Intensity Data

You can display a history of light intensity values superimposed over the saturation trend graph. This combined display can be valuable for troubleshooting, because the quality of light passing through the catheter tip directly affects the accuracy of the saturation value. Successful monitoring ensures that light intensity values remain within the limits of the bar graph display.

Real-time maximum and minimum intensity values appear as two vertical lines on each side of a vertical row of dots. This display updates every six seconds. Two horizontal lines represent the recommended operating limits for light intensity.

Removing the display of intensity data does not affect storage of the data on the monitor's disk space, and the current intensity continues to appear in the intensity bar.

**To display a history of light intensity values:**

- Touch SvO2/ScvO2.
- Touch INTENSITY DISPLAY.

# Setting Up $SvO_2$/$ScvO_2$ Monitoring

In addition to the Spacelabs Healthcare module, venous oximetry monitoring requires a Hospira optical module and a Hospira oximetry catheter. You must correctly connect all necessary cables, prepare the catheter and patient for this invasive procedure, and calibrate the catheter to begin monitoring.

The patient's current status determines which calibration method is correct.

**You can calibrate the catheter:**

- While it's in the sterile package.

  -OR-

- After it has been inserted into the patient's pulmonary artery ($SvO_2$) or venous system ($ScvO_2$), and you can verify adequate light intensity during monitoring.

Refer to *Preparing the Catheter* on page 22-7 and *Performing a Pre-Insertion (In Vitro) Calibration* on page 22-9 for additional information.

**To set up $SvO_2$/$ScvO_2$ monitoring:**

- Place the catheter's optical connector into the optical module.
- Insert the optical module's connecting cable into the $SvO_2$/$ScvO_2$ module.

The message *NOT CALIBRATED* appears and an alarm tone sounds (if alarms are ON) if you begin monitoring before you calibrate the system. The message clears after a successful calibration.

# Preparing the Catheter

Each Hospira oximetry catheter is packaged in a sterile, disposable tray, which includes a disposable optical reference. Inspect the catheter tray carefully. If you suspect damage to the tray, DO NOT USE THE CATHETER.

The catheter fiber optics are sensitive to damage. Avoid kinking, excessive manipulation, or grasping with forceps or a hemostat. Damage to the fiber optics reduces transmission of light to and from the blood, which significantly compromises oxygen saturation accuracy.

**Damage is indicated by one or more of the following:**

- *INSUFFICIENT LIGHT* message appears.
- *INTENSITY ALERT* message appears and intensity alarm sounds (if alarms are ON).
- Oxygen saturation values are inaccurate.

Perform the catheter setup according to the instructions included with the catheter. Setup instructions are included here as a convenience.

**To prepare the catheter and the optical module:**

1. Peel back the outer wrap. Do not break the seal of the inner wrap.
2. Peel back the lift tab to uncover the optical connector at the end of the tray.
3. Pull the optical connector slightly away from the tray. Place the optical module in the recess at the open end of the catheter tray (refer to *Figure 22-2*).
4. Open the end of the optical module by pulling straight out in the direction of the arrow. The *INSUFFICIENT LIGHT* message appears on the monitor.




*Figure 22-2: Placing the optical module into the catheter tray*

5 Place the optical connector into the optical module with the word TOP facing up (refer to *Figure 22-3)*. Close the module.




*Figure 22-3: Placing the optical connector into the optical module*

6 With the inner wrap still in place, press down on the black optical reference at the point labeled PUSH. Listen for a click.

***Note:***

*This step may not apply to all catheters. Check the Hospira package insert.*

The catheter is now ready for pre-insertion calibration. After a calibration, prepare the patient for catheter insertion.

# Performing a Pre-Insertion (In Vitro) Calibration

This calibration procedure takes up to 72 seconds. When calibration is successful, the message *PRE-INS CAL COMPLETE* appears and the event mark **P** appears on the oximetry trend.

**If the catheter fails calibration, verify the following:**

- A secure cable connection exists between the optical module and the $SvO_2/ScvO_2$ module.
- The catheter's optical connector is inserted properly within the optical module.
- The catheter has been replaced with a new catheter to ensure proper catheter function.

***Note:***

*Catheters are single-use only.*

Repeated calibration failures with a known good catheter may indicate a defective optical module. Replace the optical module if necessary.

**To initiate pre-insertion calibration:**

- Touch SvO2/ScvO2.
- Touch CALIBRATE.
- Touch PRE-INSERTION.
- Touch YES.

# Beginning $SvO_2/ScvO_2$ Monitoring

Follow standard hospital procedures to prepare the patient for catheter insertion.

**To prepare the catheter for insertion:**

1 Using sterile procedures, peel back the remaining inner wrap from the catheter tray. Pull the retainer (white tab) to release the catheter.

2 Grasp the catheter at approximately the five-centimeter mark and gently pull it straight out from the optical reference.

**Caution:**

**The optical fibers can be damaged if you do not draw the catheter out carefully.**

3 Prepare the catheter and insert it into the patient according to hospital procedure. Oxygen saturation readings will immediately display on the bedside monitor.

4 Verify that the light intensity signal is within the correct operating range when the catheter is positioned properly (i.e., the bars on the graph extend at least two vertical dots within the high and low range markers).

5 Perform a light intensity calibration (refer to *Performing a Light Intensity Calibration and Correcting Errors* on page 22-10).

6 Begin continuous mixed venous oxygen saturation monitoring.

# Performing a Light Intensity Calibration and Correcting Errors

A light intensity calibration adjusts the optical module's light intensity reference level to match the light intensity returned through the catheter from the patient's blood. The $SvO_2/ScvO_2$ module stores this value and signals an alarm if the detected light differs significantly from the stored light levels.

***Note:***

- *Perform a light intensity calibration only when the catheter is in the proper position in the patient.*
- *Do not begin a light intensity calibration if the signal is out of range. If this occurs, refer to Correcting Out-of-Range Light Intensity on page 22-11.*

**To initiate light intensity calibration:**

- Touch SvO2/ScvO2.
- Touch CALIBRATE.
- Touch LIGHT INTENSITY.
- Touch YES.

## Correcting Insufficient Light Intensity

The message *INSUFFICIENT LIGHT* appears when an unusually small amount of light is being received during monitoring or during pre-insertion calibration. Take the following actions:

- Take no action if this message appears while the catheter is exposed to room light during pre-insertion calibration. It disappears when the catheter is placed in the patient.
- If this message appears during pre-insertion calibration, while the catheter is connected to the optical module, verify proper connection to the module.
- Check that the tip is fully inserted into the optical reference and firmly press PUSH on the optical reference until you hear a click. Do not use the catheter if the tip is pulled out of the optical reference when you receive the catheter tray.

***Note:***

*This step may not apply to all catheters. Check the Hospira package insert.*

- Disconnect the catheter from the optical module, close the optical module lid, and place the optical module in an area out of direct light. If the message disappears, replace the catheter. If the message remains, contact a qualified field service engineer.
- Examine the catheter for kinking. If optical fibers are damaged, replace the catheter.

## Correcting Out-of-Range Light Intensity

Each time you perform a light intensity calibration, the oximetry module stores the intensity value and signals an alarm or error message if the current light level differs significantly from the stored level. Light intensity error messages serve as a reference to determine if the light at the catheter tip is adequate for accurate monitoring. Do not ignore these messages.

**The module alerts you to this condition when one of the following occurs:**

- An *INTENSITY ALERT* or *SVO2/SCVO2 DATA OUT OF RANGE* message appears.
- A low priority alarm begins.

When the monitor displays the *SVO2/SCVO2 DATA OUT OF RANGE* or *INTENSITY ALERT* message, select the intensity display feature to view a history of light intensity values. Refer to *Figure 22-4* to identify the type of abnormal intensity.

*Table 1: Abnormal Intensity Descriptions*

| Intensity | Cause | Solution |
|---|---|---|
| High | The tip may be lying against the vessel wall. | Check the position of the catheter. Reposition according to your hospital protocol. |
| Low, dampened, or erratic | A clot may have formed over the catheter tip. | Check the blood flow past the catheter. |

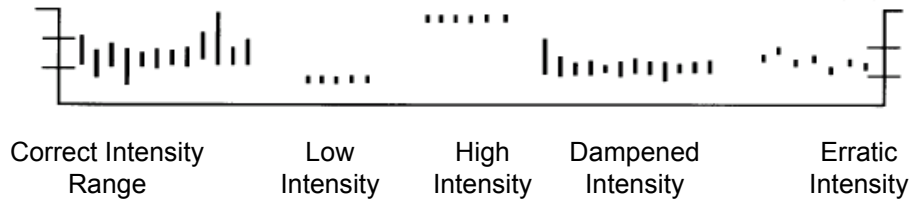



*Figure 22-4: Abnormal intensities*

**Take the following actions when a low priority alarm occurs:**

- If a Spacelabs Healthcare invasive pressure module is being used for pulmonary artery pressure monitoring, examine the pulmonary artery (PA) pressure waveform for the following:
  - Spontaneous wedge (indicating the catheter tip may lie against the vessel wall).
  - Dampening (indicating clotting over the tip of the catheter).

  Follow hospital procedure to flush the distal lumen. Reposition the catheter if necessary.
- Reposition the catheter if there is abnormal resistance when you push it through the distal lumen. If the abnormal resistance continues, the catheter fiber optics may be damaged. Replace the catheter.
- Tighten the connections between the catheter optical connector and the optical module if they appear loose.
- Replace the catheter if it contains obvious kinks.

# Performing an In Vivo Calibration

***Note:***

*Use only measured oxyhemoglobin saturation values from a co-oximeter. Do not use values calculated from a laboratory blood gas analyzer. Oxyhemoglobin values calculated on the basis of $PO_2$, pH, and temperature may be inaccurate.*

In vivo calibration compares a drawn (measured) blood gas value with the value displayed on the monitor. The catheter manufacturer recommends that the oxygenation value be checked periodically.

**The following conditions may necessitate in vivo calibration:**

- Catheter is placed without performing a pre-insertion calibration.
- Catheter has been in place for an extended period of time.
- Decaying light intensity values indicate possible damage to the fiber optics (in this case, the catheter's manufacturer recommends checking the oxygenation value every 12 hours).
- You believe the saturation reading is incorrect.

**To initiate in vivo calibration:**

- Touch SvO2.
- Touch CALIBRATE.
- Touch IN VIVO.
- Touch YES.
- Draw blood from the distal lumen when the message *DRAW BLOOD* appears. Send to the lab for analysis.
- Use the arrow keys to adjust the value if the displayed value differs from the lab value by more than four saturation units.

Perform an in vivo calibration only when the patient's oxygen saturation is relatively stable and the intensity signal is within normal limits. When calibration begins, the optical module stores the preceding five seconds of oxygen saturation data.

# Correcting Calibration Errors

The message *CALIBRATION REJECTED* appears when pre-insertion or in vivo calibration is unsuccessful.

**Take the following action as indicated:**

- Check for secure catheter connection to the optical module. Reconnect the catheter if necessary.
- Check the status message on the monitor display to verify sufficient, stable light intensity. If the *INSUFFICIENT LIGHT* message appears, refer to *Correcting Insufficient Light Intensity* on page 22-10 to correct this condition.
- Allow the optical module to warm up for one more minute, then retry.

# Correcting an $SvO_2/ScvO_2$ Display Error

If the venous oximetry value is out of the display range, the $SvO_2/ScvO_2$ value is replaced by **???**.

**Take the following action as indicated:**

- Verify proper functioning of the optical module with no error messages appearing. Replace with a known good optical module if necessary.
- Check the light intensity history to verify proper catheter function (refer to *Displaying Intensity Data* on page 22-6 and *Correcting Insufficient Light Intensity* on page 22-10).
- Perform an in vivo calibration.

# Enabling and Adjusting Alarms

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

The current limits for venous oximetry display to the right of the SvO2/ScvO2 parameter key. You can set high or low saturation limits. If the light intensity alarm is turned ON, a low priority alarm will sound in the event of an intensity alert.

**To enable and adjust alarm limits:**

- Touch SvO2/ScvO2.
- Touch ALARM LIMITS.
- Select ALARMS / ON.
- Select HI= or LO=.
- Use the arrow keys to adjust.

**To set the light intensity alarm:**

- Touch SvO2/ScvO2.
- Touch ALARM LIMITS.
- Select LIGHT INT / ON or OFF.

# Adjusting Timebase and Scale

The $SvO_2/ScvO_2$ module stores the most recent 16 hours of saturation trend data. You can view this data graphically in 1-, 2-, 4-, 8-, or 16-hour timebases. Data is displayed in one-minute increments on 1- to 4-hour graphs, in two-minute increments on the 8-hour graph, and in four-minute increments on the 16-hour graph.

**You can select one of three sizes for the trend graph:**

- 30% to 70%
- 40% to 80%
- 50% to 90% (default)

**To select a timebase:**

- Touch SvO2 or ScvO2.
- Touch SETUP.
- Touch TIMEBASE X-HOURS.
- Select the desired timebase.

**To change trend graph size:**

- Touch SvO2 or ScvO2.
- Touch SETUP.
- Touch SCALES.
- Use the arrow keys to adjust.

# Selecting the Operating Mode ($SvO_2$ or $ScvO_2$)

The $SvO_2/ScvO_2$ module operating mode can be changed, depending on catheter placement.

- If the catheter is to be placed centrally, select $ScvO_2$.
- If this catheter is to be placed in the patient's leg, select $SvO_2$ The default operating mode is $ScvO_2$.

**To select the operating mode:**

- Touch SvO2 or ScvO2.
- Touch SETUP.
- Touch OPERATING MODE.
- Touch SvO2 or ScvO2.
- Touch YES to select the operating mode.

# Restoring Default Settings

The RESTORE SETTINGS key changes the user-configurable settings for all parameters in the module to the defaults previously stored as user settings (refer to the *Ultraview SL Module Configuration Manager System Administration Guide*, P/N 070-1245-xx).

**To restore default settings:**

- Touch SvO2 or ScvO2.
- Touch SETUP.
- Touch RESTORE SETTINGS.
- Select YES.

# Obtaining Oximetry Calculations

You can use the Calculations feature to obtain specific values for the oximetry measurements listed below.

***Note:***

*If an $SaO_2$ value is available, it can be used in place of the $SpO_2$ value.*

**Arterial oxygen content — Ca**

$CaO_2 = (1.34 \times Hgb \times SaO_2/100) + (0.0031 \times PaO_2)$

**Venous oxygen content — Cv**

$CvO_2 = (1.34 \times Hgb \times SvO_2/100) + (0.0031 \times PvO_2)$

**Arterial-venous oxygen content difference**

$avDO_2 = CaO_2 – CvO_2$

**Oxygen availability or oxygen delivery**

$O_2AV = CaO_2 \times CO \times 10$

**Oxygen consumption**

$VO_2 = avDO_2 \times CO \times 10$

You must manually enter laboratory values for $PaO_2$, $PvO_2$, pulse oximetry ($SpO_2$), and hemoglobin (Hgb) to obtain calculations. Values for venous oxygen saturation ($SvO_2$) or central venous oxygen saturation ($ScvO_2$) are automatically displayed when data is available in the Spacelabs Healthcare system.

**To obtain oxygenation calculations:**

- Touch SvO2 or ScvO2.
- Touch CALCS.
- Select a manually entered value(s) for $PaO_2$, $PvO_2$, Hgb.
- Use the arrow keys to adjust.
- Touch ENTER.

# Printing Oximetry Data

You can print venous oximetry data in two formats: the current trend or the results of the most recent set of oxygenation calculations.

**To print saturation data:**

- Touch SvO2 or ScvO2.
- Touch PRINT.
- Select SvO2 TREND or CALC RESULTS.

# Storing or Reading Data

The last 15 minutes of data gathered by the $SvO_2/ScvO_2$ module can be stored on the optical module's hard disk before disconnecting. That data can be read back into the $SvO_2/ScvO_2$ module. The stored information includes the year, month, day, hour, and minute of collection.

**To read or store data in the optical module:**

- Touch SvO2 or ScvO2.
- Touch STORE/READ.
- Select STORE or READ.
- Touch YES.
- For READ only, use the arrow keys to select the scale.

# $SvO_2$ Alarm Delays

*Table 2: $SvO_2$ Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| $SvO_2$ High | 1 to 100 | Less than 1 second |
| $SvO_2$ Low | 0 to 99 | |
| $ScVO_2$ High | 1 to 100 | |
| $ScVO_2$ Low | 0 to 99 | |

# $SvO_2/ScvO_2$ Troubleshooting Guide

**Caution:**

**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

***Note:***

*Catheters should be handled according to your hospital's protocol.*

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **INTENSITY ALERT or SVO2/SCVO2 DATA OUT OF RANGE message appears** | ■ Faulty catheter position within vessel. | ■ Check for spontaneous wedge or balloon inflation; if present, reposition the catheter. |
| | ■ A clot exists over the catheter tip. | ■ Flush the distal lumen. |
| | ■ Loose connections between catheter optical connector and optical module. | ■ Tighten the connections. |
| | ■ Kinked or damaged fiber optics in the catheter. | ■ Replace the catheter. |
| **INSUFFICIENT LIGHT message appears** | ■ Catheter was exposed to room light during pre-insertion calibration. | ■ No action required; status message only. |
| | ■ Catheter is kinked. | ■ Check the catheter. |
| | ■ Faulty connection between catheter and optical module. | ■ Fully insert the tip into the optical reference. |
| **CALIBRATION REJECTED message appears** | ■ Faulty connection between catheter and optical module. | ■ Reconnect. |
| | ■ Optical module not warmed up. | ■ Wait one minute and retry. |
| | ■ The pre-insertion calibration was attempted when the optical module was not conected, when the light intensity was insufficient, or when the light intensity varied. | ■ Check that the optical module is properly connected to the $SvO_2$/$ScvO_2$ module, then retry pre-insertion calibration. |

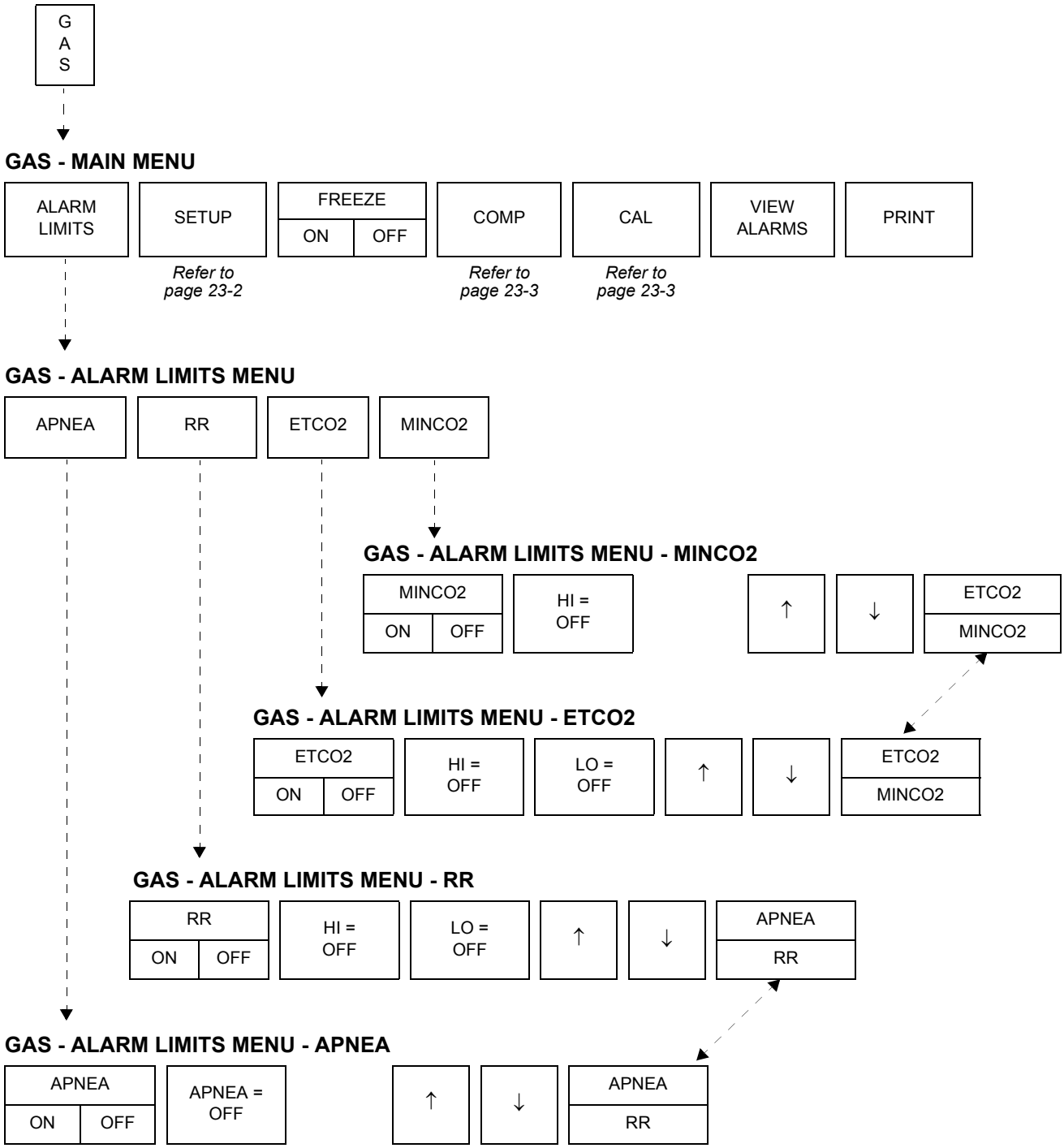
## $SvO_2/ScvO_2$

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **??? is displayed in place of $SvO_2$ value** | ■ Value out of range. | ■ If an optical module error message also displays, replace the optical module. |
| | ■ Poor light intensity. | ■ Display light intensity history to verify. |
| | ■ Pre-insertion calibration insufficient. | ■ Perform in vivo calibration. |
| **OPTICAL MODULE FAULT message appears** | ■ The optical module cannot perform an acurate reading. | ■ Restart the $SvO_2/ScvO_2$ module or replace the optical module. |
| **NO OPTICAL MODULE message appears** | ■ The optical module is disconnected from the $SvO_2/ScvO_2$ module. | ■ Connect the optical module to the $SvO_2/ScvO_2$ module. |
| **RECONNECT OPTICAL MODULE message appears** | ■ The optical module must be reconnected to the $SvO_2/ScvO_2$ module for a reading to occur. | ■ Reconnect the optical module. |
| **OPTICAL MODULE MEMORY ERROR message appears** | ■ An optical module memory device error has occurred. | ■ Replace the optical module. |
| **CALIBRATION ERROR message appears** | ■ An error occurred during calibration. | ■ Retry the calibration. |
| **NOT CALIBRATED message appears** | ■ The $SvO_2/ScvO_2$ channel has not been calibrated. | ■ Perform the calibration. |

# Capnography

## Directory of Keys

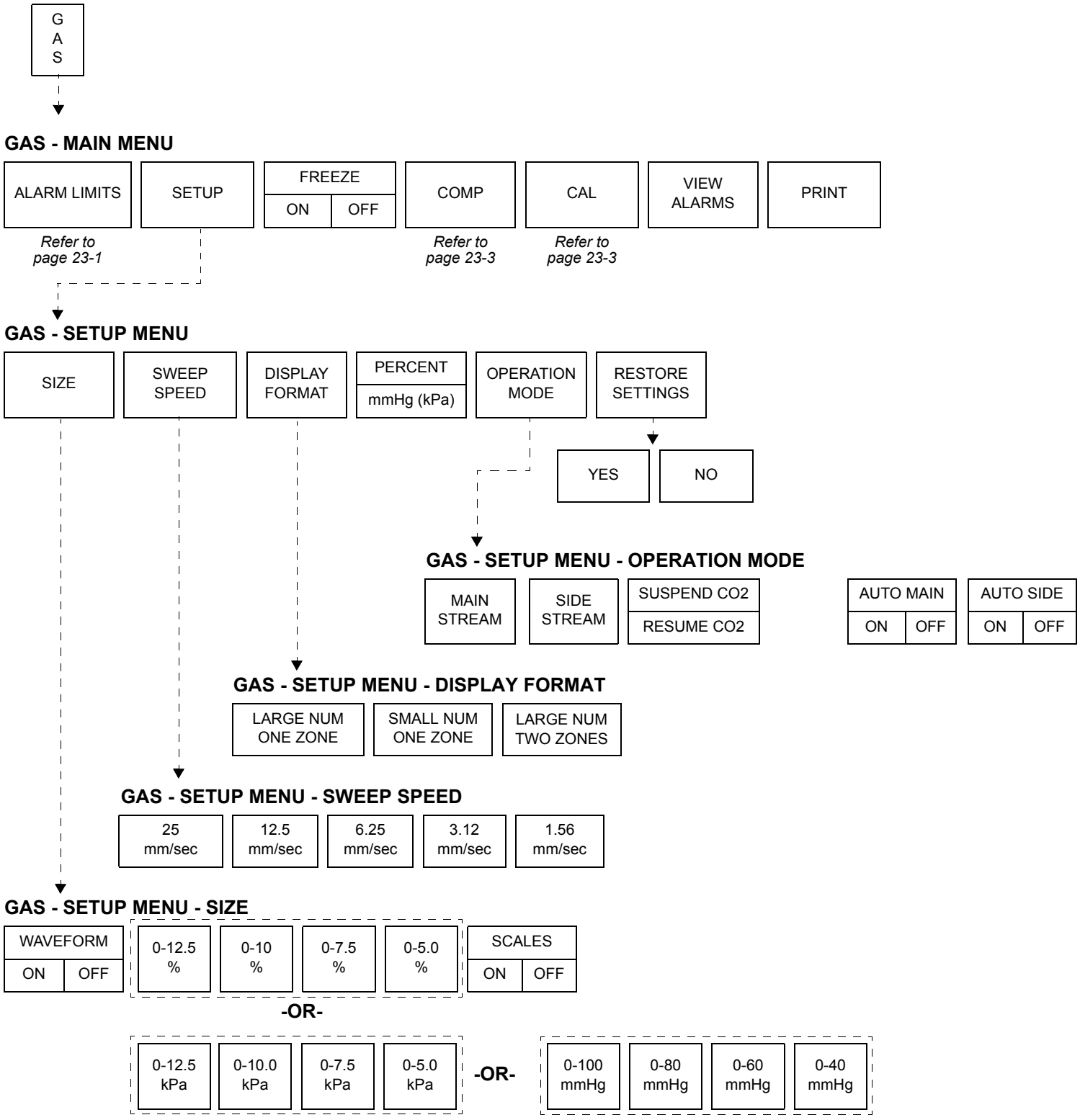
### Alarms Limits




***Note:***

*Based on features purchased, more or fewer keys may appear here than on your display.*

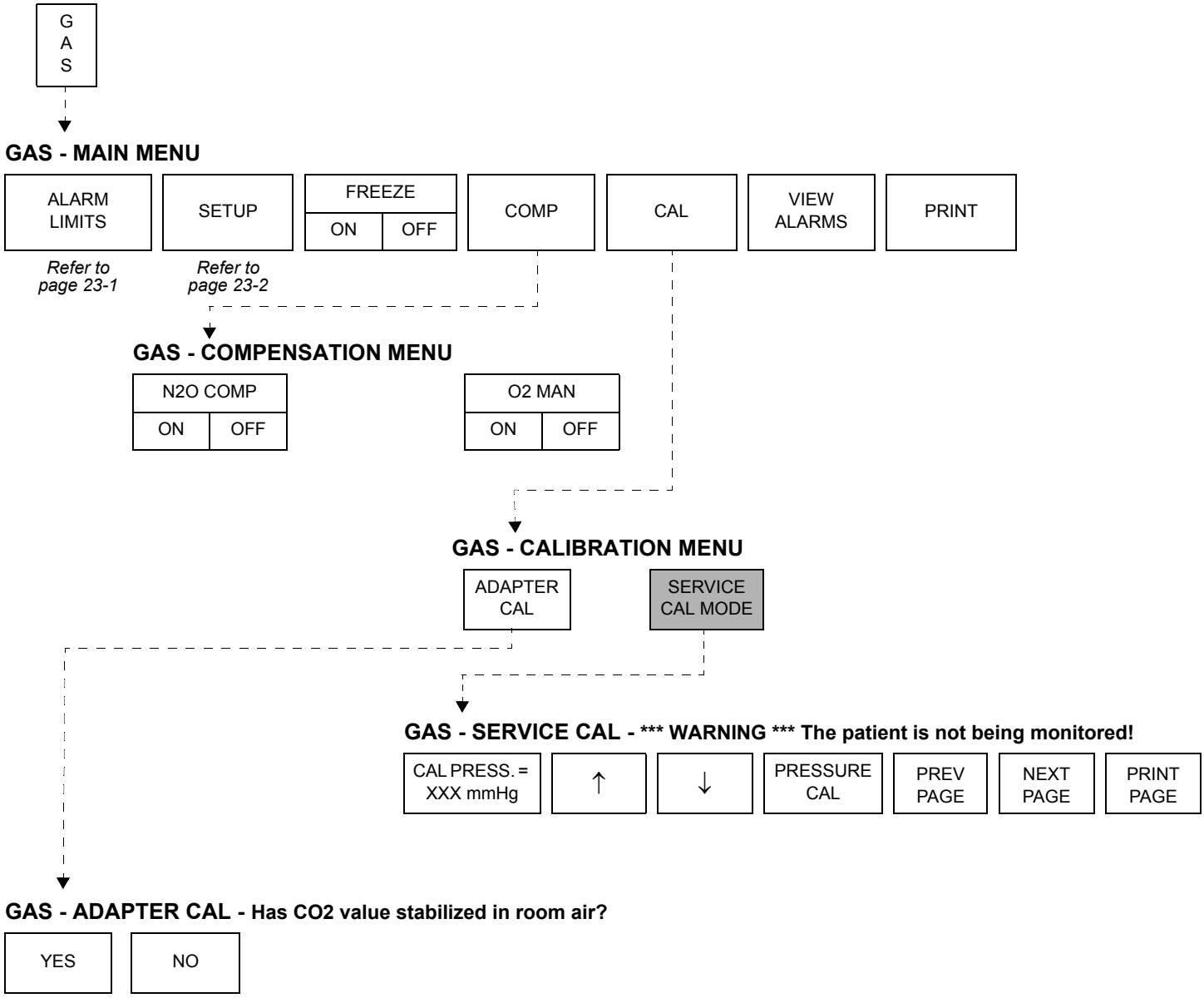
# Setup




***Note:***

*Based on features purchased, more or fewer keys may appear here than on your display.*

## Compensation and Calibration




***Note:***

*Based on features purchased, more or fewer keys may appear here than on your display.*

# Capnography

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## Overview

The 91517 capnography module is a mainstream and sidestream gas analyzer designed to measure the concentration of carbon dioxide in a gas mixture and to aid in determining the patient's ventilatory, circulatory, and metabolic status. Mainstream (nondiverting) and sidestream (diverting) capnography are highly accurate methods of measuring respiratory gas values.

Mainstream monitoring uses a self-calibrating $CO_2$ sensor to ensure continuous monitoring without interruption of connection. Reusable, lightweight (<14 grams), or single-use airway adapters are available for both adult and neonatal (low dead space) patients. Respiration can be monitored via an airway adapter and endotracheal or tracheostomy tubes using the mainstream function of the module.

Sidestream monitoring uses adult, pediatric, and infant sampling lines. Respiration can be monitored via an airway adapter, nasal cannula, or nasal/oral cannula using the sidestream function of the module. Sidestream monitoring diverts patient gases at a rate of 50 ml/min (±10 ml/min).

The capnography module includes a small, lightweight sensor that continuously measures the end-tidal and minimum carbon dioxide ($CO_2$) levels in the patient's airway. The sensor head contains a small infrared transducer that accurately measures the $CO_2$ in the airway. The sensor is connected to the airway by a disposable or reusable airway adapter. These adapters are available in adult and neonatal sizes.

The capnography module automatically compensates for the ambient barometric pressure to ensure accurate readings.

The 91517 capnography module can be configured to automatically detect whether to monitor using mainstream capnography or sidestream capnography. However, these configurations can be set manually, if desired.

This chapter includes cautions specifically related to capnography. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to several physiological parameters or to the monitoring system itself.

The health or life of a patient or clinician may be endangered if these warnings are not addressed.

### *Warning:*

- ***Although the 91517 capnography module detects and reports apnea conditions, it is not intended to be a primary diagnostic apnea monitor and/or apnea recording device.***
- ***Do not immerse the device, patient cables, sensors, or airway adapters (except reusable airway adapters) in water, solvents, or cleaning solutions (refer to the detailed cleaning instructions in* Cleaning/Disinfecting *on page 23-26).***
- ***The mainstream/sidestream capnography module is not to be used in the presence of flammable anesthetics or other flammable gases.***

Equipment may be damaged or cease to function properly if the cautions are not addressed.

### Caution:

- **Use only Spacelabs Healthcare mainstream sensors and airway adapters with the 91517 capnography module, and use only Spacelabs Healthcare sidestream nasal and nasal/oral cannulas and airway adapter. Other sensors may plug in, but will not operate. The module may not function or become damaged if other airway adapters are used.**
- **If the patient's airway is configured with a closed suctioning system, make sure the airway adapter is placed close to the suctioning system (on the ventilator side). This will help ensure that the sampling adapter is not impaired during and after suctioning.**
- **Patient monitoring may be interrupted due to electromagnetic interference caused by the presence of electromagnetic devices (i.e., electrocautery).**
- **Follow the cleaning instructions listed in Cleaning/Disinfecting on page 23-26 of this document for cleaning the mainstream and sidestream $CO_2$ sensors.**
- **The disposable airway adapter, nasal and nasal/oral sampling cannulas, and the airway adapter kits are intended for single patient use. Do NOT reuse or sterilize these disposable adapters, because system performance will be compromised.**
- **Properly vent exhaust gases from the capnography module outlet port away from capnography module.**
- **Do not to insert any object other than the sidestream sample cell into the inlet port of the $CO_2$ module.**
- **Inspect the mainstream $CO_2$ sensor and airway adapter connections to ensure correct positioning.**
- **Do not use a damaged sensor, a damaged airway adapter, or a damaged sampling cell or sampling line.**
- **Position mainstream airway adapters with windows in a vertical position, and NOT in a horizontal position. This helps keep patient secretions from pooling on the windows.**
- **Position sidestream airway adapters with the tubing in an upright position. This helps keep patient secretions from pooling into the tubing.**

- **To prevent moisture from draining into the mainstream airway adapter or into the sidestream airway adapter tubing, do NOT place the adapter in a gravity dependent position.**
- **It is recommended that the mainstream airway adapter and the sidestream airway adapter be removed from the circuit whenever an aerosolized medication is delivered. The increased viscosity of the medications may contaminate the sensor windows, causing the sensor to fail prematurely.**
- **Remove the sidestream sampling line sample cell from the capnography module inlet port when not in use.**
- **Remove the airway adapter from the breathing circuit when not in use, or when the sidestream sampling line sample cell is not connected to the module.**

***Note:***

- *To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).*
- *Always ensure the integrity of the patient breathing circuit after insertion of the mainstream or sidestream airway adapter by verifying a proper $CO_2$ waveform (capnogram) on the monitor display.*
- *Monitor the capnogram for an elevated baseline. If an elevated baseline is observed, verify patient condition first. If the care giver determines that the patient condition is not contributing to the elevated baseline, follow the instructions detailed in this manual for zeroing the sensor or module.*
- *Components of this product and its associated accessories that have patient contact are free of latex.*
- *Do not apply tension to the sensor cable.*
- *Do not store sensors at temperatures less than 14° F (-10° C) or greater than 131° F (55° C).*
- *Do not operate sensors at temperatures less than 50° F (10° C) or greater than 104°F (40° C).*

# $CO_2$ Indications for Use

Continuous monitoring of $CO_2$ and respiration rate are essential elements of patient care. The 91517 capnography module performs both mainstream and sidestream monitoring of intubated and non-intubated patients who require ventilator support, procedural sedation, transport, and anesthesia. Mainstream or sidestream monitoring may also be deemed appropriate by the attending care giver. Continuous monitoring of $CO_2$ is extremely useful in environments where patient $CO_2$ levels may fluctuate.

**The following substances can influence $CO_2$ measurements:**

- Elevated oxygen levels
- Nitrous oxide
- Halogenated agents

When a patient's $CO_2$ level fluctuates, you can compensate by administering high oxygen and/or nitrous oxide. Halogenated anesthetic agents may also alter $CO_2$ readings, but $CO_2$ can still be monitored when these agents are present at normal clinical levels. The presence of Desflurane in the exhaled breath beyond normal values (5 to 6%) may positively bias measured carbon dioxide values by an additional 2 to 3 mmHg.

# Patient Connection

## Operating Modes

The 91517 capnography module measures $CO_2$ in either MAINSTREAM or SIDESTREAM mode. The operation of the module in either mode is dependent on the proper equipment and monitor settings. The current operation mode is displayed in the upper right corner of the numeric area of the GAS channel. The text MODE will be displayed over MAIN or SIDE.

***Note:***

*The 91517 capnography module has two capnography sensor receptacles (for a mainstream capnography sensor and a sidestream capnography sensor). The 91517 can automatically determine its operational mode (MAINSTREAM or SIDESTREAM) based on the sensors that are connected. This feature can be disabled if desired.*

## Changing the Operating Mode

The 91517 capnography module can be set to automatically switch between the MAIN and SIDE modes.

- To set automatic switching, select the AUTO MAIN ON/OFF or AUTO SIDE ON/OFF keys, which are located in the OPERATIONS MODE menu, found under the GAS SETUP menu.
  - Select AUTO MAIN ON to set the module to automatically switch to MAINSTREAM mode when a mainstream sensor is attached. Selecting this key has no immediate effect on the operating mode. The factory default is ON.
  - Select AUTO SIDE ON to set the module to automatically switch to SIDESTREAM mode when a sidestream sensor is attached. Selecting this key has no immediate effect on the operating mode. The factory default is ON.

If automatic switching is ON, the last type of sensor that is plugged in (either a mainstream or sidestream sensor) determines the active mode.

If AUTO MAIN AND AUTO SIDE are set to OFF, then the mode selected in the menu (MAINSTREAM or SIDESTREAM) is the active mode, even if there is no mainstream or sidestream sampling line connected.

## Default Operating Mode

The module default setting is SIDESTREAM mode, with AUTO MAIN ON and AUTO SIDE ON. In this configuration, when a sidestream sampling kit and the mainstream sensor are plugged in at the same time, SIDESTREAM mode is the active mode.

## Manually Selecting the Operating Mode

If OFF is selected in either the AUTO MAIN ON/OFF mode or AUTO SIDE ON/OFF mode, then you must manually select MAINSTREAM or SIDESTREAM, under the OPERATION MODE menu, to switch between mainstream and sidestream monitoring.

If the sensor for the current operating mode is disconnected, but the sensor for the other operating mode is present, and the current mode's automatic switching setting is ON, the operating mode will change to use the other sensor. The key for the previously set mode will be deselected, and the key for the currently set mode will be highlighted.

**To select operational mode:**

- Plug the module into the monitor.
- Select GAS.
- Select SETUP.
- Select OPERATION MODE.

**To enable or disable automatic operational mode detection:**

- Set AUTO MAIN ON/OFF to OFF to disable automatic mainstream detection or to ON to enable automatic mainstream detection.
- Set AUTO SIDE ON/OFF to OFF to disable automatic sidestream selection or to ON to enable automatic sidestream selection.

***Note:***

- *Capnography is not analyzed during unit warm-up.*
- *The typical initial warm-up period is two to five minutes. The warm-up period varies based on the temperature of the sensor and the room.*
- *The airway adapter may require regular cleaning or replacement if the capnography module is used on patients that emit excessive mucous.*

# Initialization

Insert the capnography module into the monitor and power the monitor ON.

- A self test of the capnography module is performed at initial power on or upon a restart of the monitor.
- After the self test of the capnography module is completed, and communication with the monitor is established, the GAS channel will become available.
- If a mainstream $CO_2$ sensor or a sidestream sampling kit is not connected, the message *CO2 SENSORS DISCONNECTED – Check Sensor or Replace* is displayed in the waveform area.
- If a mainstream $CO_2$ sensor or a sidestream sampling kit is connected to the capnography module, the general message *CO2 SENSOR WARMING UP* may be displayed followed by a prompt message, *CO2 SENSOR STABILIZING*. The warm-up message may be displayed for up to two minutes, depending on the temperatures of the environment, the module, and the sensor. The stabilizing message may be displayed for up to five minutes, also depending on the temperatures of the environment, the module, and the sensor. If the sensor is already in the normal operating temperature range, these messages may not be displayed.
- After the *CO2 SENSOR WARMING UP* message is no longer displayed in the waveform zone, the monitor will display a normal display based on the default settings.

- If the mainstream $CO_2$ sensor needs to be calibrated, the waveform will be displayed as a flat line and all $CO_2$ numeric values will be undefined, displaying question marks.
- During initialization, a GAS channel normal display may be displayed before the *CO2 SENSOR WARMING UP* message is displayed, and some anomalies (for example, spikes, pulses, etc...) may show up on the waveform.
- The module starts with no breath detected. All alarms are disabled until a respiratory rate is calculated following the detection of three continuous patient breaths.
- The module will return to no breath detected mode whenever the ACKNOWLEDGE ALARM key is touched.

# Patient Connection—Mainstream Operation

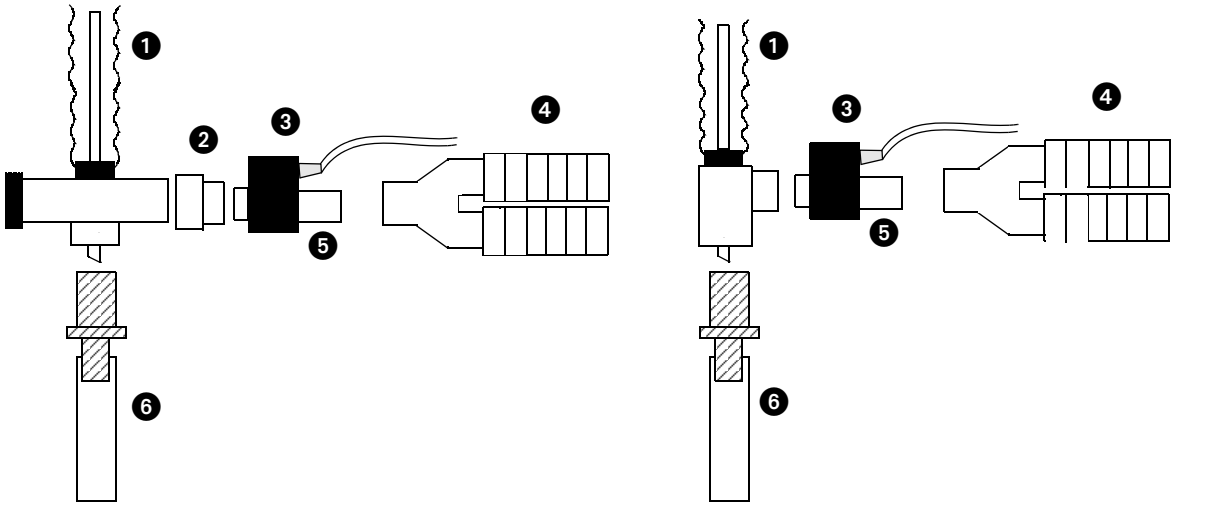
Respiration can be monitored via an endotracheal or tracheostomy tube.

There are several variations of closed-circuit tracheal suction systems that can be used with Spacelabs Healthcare capnography units. Spacelabs Healthcare recommends the Ballard style tracheal suction system (refer to *Figure 23-1*).

Spacelabs Healthcare does not recommend using traditional setups that require the airway adapter to be in line with the endotracheal tube. However, if you prefer a traditional setup, such as the Ballard Model 2205-style, use the Ballard Model 112 adapter to move the airway adapter away from the suction catheter.

Closed circuit tracheal suction systems (such as those provided by Ballard) extend the life of the endotracheal tube and associated tubing, by allowing the endotracheal tube to be periodically suctioned without detaching it from the ventilator circuit. Spacelabs Healthcare recommends using Ballard Model 221 elbow closed tracheal suction systems, or similar systems, with Spacelabs Healthcare capnography units. This type of system allows the Spacelabs Healthcare airway adapter to be placed outside the tube through which fluids are being suctioned, reducing the chance of occluding the airway.

*Figure 23-1* shows examples of setups using the Ballard Model 221 and Model 2205-style systems (with Model 112 adapter). Similar closed systems, such as the Concord Portex (not shown), must be placed in the ventilator circuit in the same positions as shown in *Figure 23-1*.




**Ballard closed tracheal suction system with adapter (Model 2205/Adapter #112)**

**Ballard elbow closed tracheal suction system (Model 221)**

*Figure 23-1: Ballard setups*

1. Suction catheter
2. Ballard adapter #112
3. Sensor head
4. Ventilator circuit
5. Mainstream airway adapter
6. Endotracheal tube

## Mainstream Operation

The module must have a compatible mainstream $CO_2$ airway adapter.

**For $CO_2$ sampling to occur in MAINSTREAM mode:**

1 Connect the mainstream $CO_2$ sensor to the module, as shown in *Figure 23-2*.

2 Place the mainstream sensor on a mainstream $CO_2$ airway adapter, as shown in *Figure 23-3*.

3 Ensure that the current operation mode, MAIN, displays to the right of the GAS key. If MAIN is not displayed, touch the GAS key, touch SETUP, touch OPERATION MODE, and then touch MAINSTREAM.

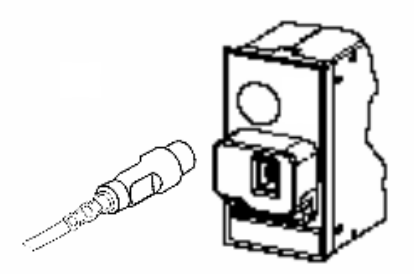


*Figure 23-2: Mainstream $CO_2$ sensor connection to module*

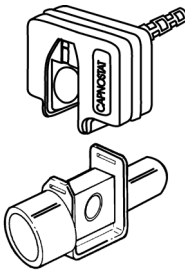



*Figure 23-3: Mainstream $CO_2$ sensor and airway adapter*

**To start mainstream capnography monitoring automatically:**

- Plug the module into the monitor.
- Plug the Mainstream sensor connector into the module, as shown in *Figure 23-2*.
- Verify that MODE MAIN is displayed to the right of the GAS key.
- Perform sensor calibration, if necessary.
- Prepare the patient according to hospital procedures.
- Select the appropriate airway adapter (neonate or adult).
- Verify that the airway adapter windows are clean and dry.
- Place the sensor head over the airway adapter and perform an adapter calibration, if necessary.
- Remove the airway adapter from the sensor head.
- Insert the airway adapter into the ventilator circuit and Ballard-style tracheal suction system (if present), as shown in *Figure 23-1*.
- Attach the sensor head to the airway adapter.
- Ensure that the sensor head is always positioned above the ventilator circuit, so that moisture will not enter the adapter.

**To start mainstream capnography monitoring manually:**

- Plug the module into the monitor.
- Plug the Mainstream sensor connector into the module, as shown in *Figure 23-2*.
- Touch GAS.
- Touch SETUP.
- Touch OPERATION MODE.
- Select MAINSTREAM as the operational mode.
- Perform sensor calibration, if necessary.
- Prepare the patient according to hospital procedures.
- Select the appropriate airway adapter (neonate or adult).
- Verify that the airway adapter windows are clean and dry.
- Place the sensor head over the airway adapter and perform an adapter calibration, if necessary.
- Remove the airway adapter from the sensor head.
- Insert the airway adapter into the ventilator circuit and Ballard-style tracheal suction system (if present), as shown in *Figure 23-1*.
- Attach the sensor head to the airway adapter.
- Ensure that the sensor head is always positioned above the ventilator circuit, so that moisture will not enter the adapter.

# Patient Connection—Sidestream Operation

The sidestream sampling line consists of a sample cell on one end that plugs into the sidestream sensor receptacle of the 91517 module. The other end of the sampling line is connected to the patient either via a cannula or using a sampling T, as shown in *Figure 23-4*.

**Caution:**

- **Do not use sidestream $CO_2$ monitoring on patients who cannot tolerate the removal of 50 ml/min from the airway, or on patients who cannot tolerate additional deadspace in the circuit.**
- **When using the nasal/oral sampling cannula do NOT cut the oral cannula tip when the cannula is placed on the patient.**
- **Periodically inspect the sidestream sampling tubing for kinks.**

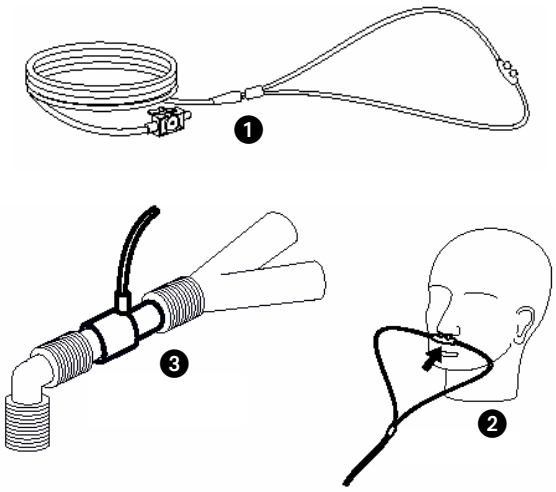



*Figure 23-4: Sidestream capnography setup*

1. Cannula and sampling cell
2. Cannula
3. Sampling T

## Sidestream Operation

The module must have a compatible sidestream sample line.

**For $CO_2$ sampling to occur in SIDESTREAM mode:**

1 Ensure that sidestream is the mode selected: touch GAS, touch SETUP, touch OPERATION MODE, and then touch SIDESTREAM.

2 Connect the sampling line sample cell to the inlet port of the module, as shown in *Figure 23-5*. The inlet port is rectangular and is located on the metal container on the front of the module. A click will be heard when the sample cell is properly inserted.

3 Insert the sample cell into the receptacle to automatically start the sampling pump. Remove the sample cell to turn the sampling pump OFF.

4 To remove the sampling line sample cell, press down on the locking tab and pull the sample cell from the inlet port.

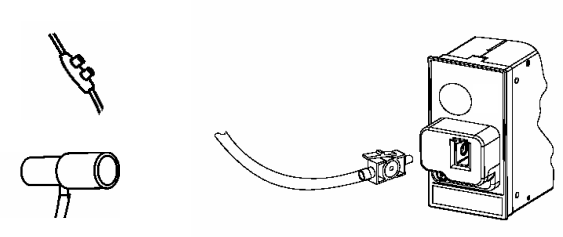


*Figure 23-5: Connecting the sampling cell to the sidestream port*

| **To start sidestream capnography monitoring automatically:** | **To start sidestream capnography monitoring manually:** |
|---|---|
| • Plug the module into the monitor.<br>• Plug the sidestream sensor connector into the module. | |
| • Verify that MODE SIDE is displayed to the right of the GAS key. | • Touch GAS.<br>• Touch SETUP.<br>• Touch OPERATION MODE.<br>• Select SIDESTREAM as the operational mode. |
| • Prepare the patient according to hospital procedures.<br>• Select the appropriate airway adapter (neonate or adult).<br>• Verify that the sample cell windows are clean and dry.<br>• Place the other end of the sampling line (cannula or sampling T) into the patient's respiration circuit.<br>• Perform sensor calibration, if necessary. | |

# Suspending and Resuming $CO_2$ Monitoring

$CO_2$ monitoring can be suspended from the GAS menu. When $CO_2$ is suspended, or when the current operating mode's sensor is detached, all information related to MINCO2, ETCO2, and RR are removed from all displays, including the numeric values, parameter labels, small alarm bells, and units of measurement. If $CO_2$ processing is suspended, the message *CO2 SAMPLING SUSPENDED* displays.

| **To suspend $CO_2$ monitoring:** | **To resume $CO_2$ monitoring:** |
|---|---|
| • Touch GAS.<br>• Touch SETUP.<br>• Touch OPERATION MODE. | |
| • Touch SUSPEND CO2. | • Touch RESUME CO2. |

***Note:***

*The CO2 SAMPLING SUSPENDED message displays on the prompt line under any gas alarm conditions. When the alarm message clears, this message displays on the waveform display.*

# Calibrating the Sensors

## Calibrating the Airway Adapter

To compensate for the optical differences between adult and neonatal airway adapters, airway adapter calibration must be performed each time you switch between these adapter types.

***Note:***

- *During calibration, keep the sensor and airway adapter away from all sources of $CO_2$ (including the patient's and your own exhaled breath and ventilator exhaust valves).*
- *An adapter calibration cannot be performed until the number of seconds equal to the apnea limit have elapsed.*

**To calibrate the airway adapter in MAINSTREAM mode:**

- Place the $CO_2$ sensor and adapter away from all sources of $CO_2$.
- Touch GAS.
- Touch CAL.
- Select the appropriate airway adapter (neonate or adult).
- Place the sensor head over the airway adapter.
- Touch ADAPTER CAL.
- Touch YES.

**To calibrate the airway adapter in SIDESTREAM mode:**

- Place the sidestream $CO_2$ sampling line away from all sources of $CO_2$ for at least 30 seconds.
- Touch GAS.
- Touch CAL.
- Touch ADAPTER CAL.
- Touch YES.

## Calibrating the $CO_2$ Sensor

A $CO_2$ sensor must be calibrated the first time that sensor is connected or when the *PERFORM ADAPTER CAL* message appears. The sensors do not require calibration at each power ON. Once calibrated, the sensor can be unplugged and reconnected without being recalibrated.

### Caution:

**Do not remove the mainstream $CO_2$ sensor or the sidestream sampling line sample cell from the capnography module during calibration.**

***Note:***

- *A sensor calibration is required whenever the $CO_2$ sensor is changed.*
- *To maintain optimum performance of the sensor and capnography module, a sensor calibration verification should be performed at least once a week.*
- *Zero cell and reference cell calibration are not required for sidestream $CO_2$ sensors.*

**Zero cell calibration of $CO_2$ sensor (mainstream operation only):**

- Remove the airway adapter from the sensor head (if present).
- Place the sensor on the zero cell.
- When the message *CO2 ZERO CAL COMPLETED* appears, remove the sensor from the zero cell and place it on the reference cell (REF).

**Reference cell calibration of $CO_2$ sensor (mainstream operation only):**

- Remove the airway adapter from the sensor head (if present).
- Place the sensor on the reference cell.
- When the message *CO2 REF CAL COMPLETED* appears, remove the sensor from the reference cell (an airway adapter calibration may be required).
- The sensor is ready for use.

# Selecting Gas Compensation

The presence of oxygen and nitrous oxide affect the measurement of $CO_2$ by infrared analysis. Appropriate compensations must be enabled to obtain accurate end-tidal $CO_2$ readings when increased levels of $O_2$ (greater than 60%) or $N_2O$ (greater than 50%) are present in the airway.

***Note:***

- *High concentrations of $O_2$ will cause a lower than expected $CO_2$ reading.*
- *High $N_2O$ level will cause a higher than expected $CO_2$ reading.*

**To select gas compensation:**

- Touch GAS.
- Touch COMP.
- Touch N2O COMP/ ON if $N_2O$ is greater than 50%.

**To enable or disable COMPENSATION mode:**

- Select O2 MAN/ ON to manually turn the compensation ON.
- Select O2 MAN/ OFF to manually turn the compensation OFF.

# Display Formats

When you first connect the module to a monitor, the GAS parameter key displays adjacent to a flat waveform if a $CO_2$ sensor is connected. Otherwise, a *GAS-CO2 SENSORS DISCONNECTED* message displays.

Text is displayed in one of following user-selectable formats: LARGE NUM ONE ZONE, LARGE NUM TWO ZONES, or SMALL NUM ONE ZONE.

## Large Numerics, One Zone

- The LARGE NUM ONE ZONE format (refer to *Figure 23-8*) is the default display format for bedside monitors.

## Large Numerics, Two Zones

- Both the numeric values and the waveform are clearly visible (*Figure 23-11*).
- This format requires two parameter zones for the GAS parameter.

## Small Numerics, One Zone

- This format allows the waveform to be clearly visible if VIEW ALARMS is not selected. However, you can use one of the large-numeric formats for routine monitoring.
- The split format is available for central monitors only (refer to *Figure 23-12)*.

Touching the VIEW ALARMS key replaces all text in the waveform zone with alarm limit labels and values for respiratory rate, $EtCO_2$, minimum $CO_2$, and apnea (refer to *Figure 23-9* and *Figure 23-10*). The alarm limit information remains displayed until another display format is selected or until the monitor returns to its normal display.

**To select a display format:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Select LARGE NUM ONE ZONE, LARGE NUM TWO ZONES, or SMALL NUM ONE ZONE.

**To display alarm limit data in the waveform area:**

- Touch GAS.
- Touch VIEW ALARMS.

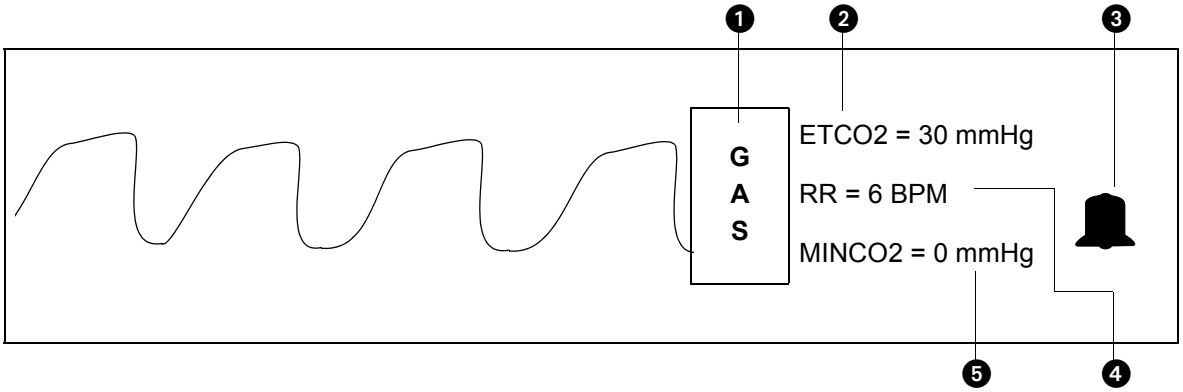



*Figure 23-6: Bedside monitor, SMALL NUM ONE ZONE (waveform ON, scales OFF)*

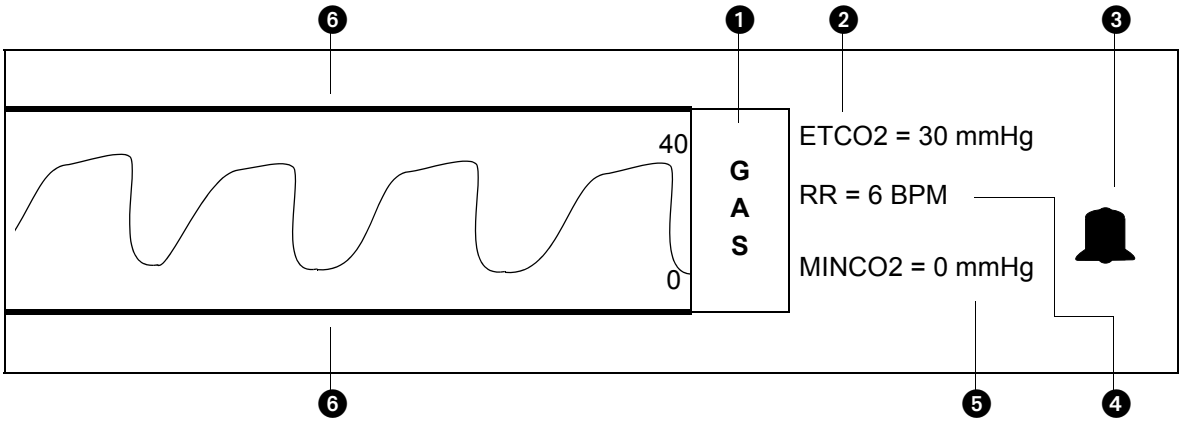



*Figure 23-7: Bedside monitor, SMALL NUM ONE ZONE (waveform ON, scales ON)*

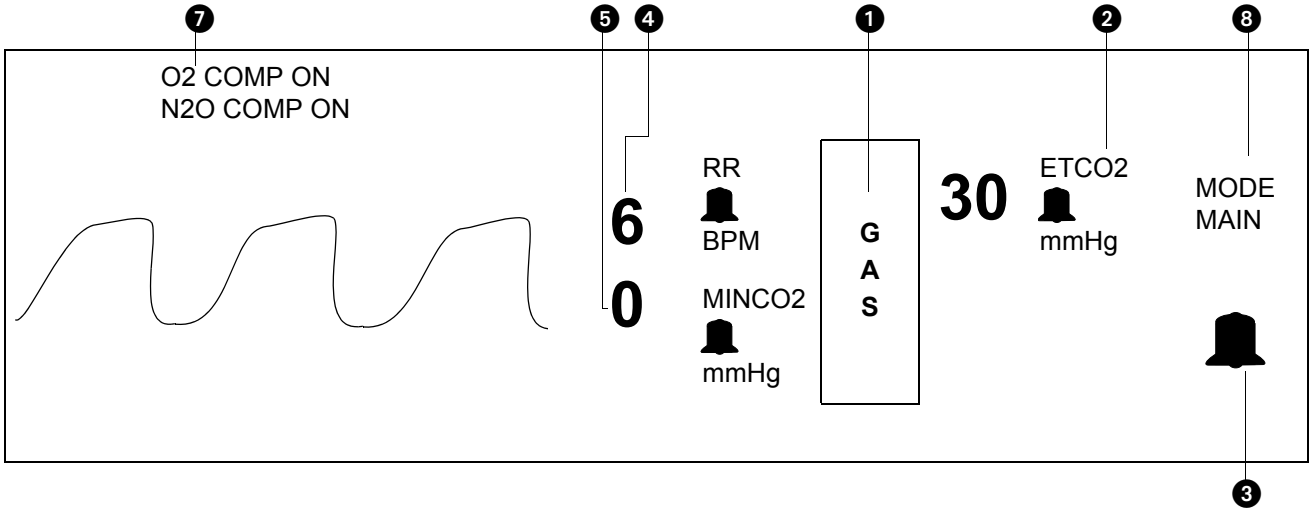



*Figure 23-8: Bedside monitor, LARGE NUM ONE ZONE*

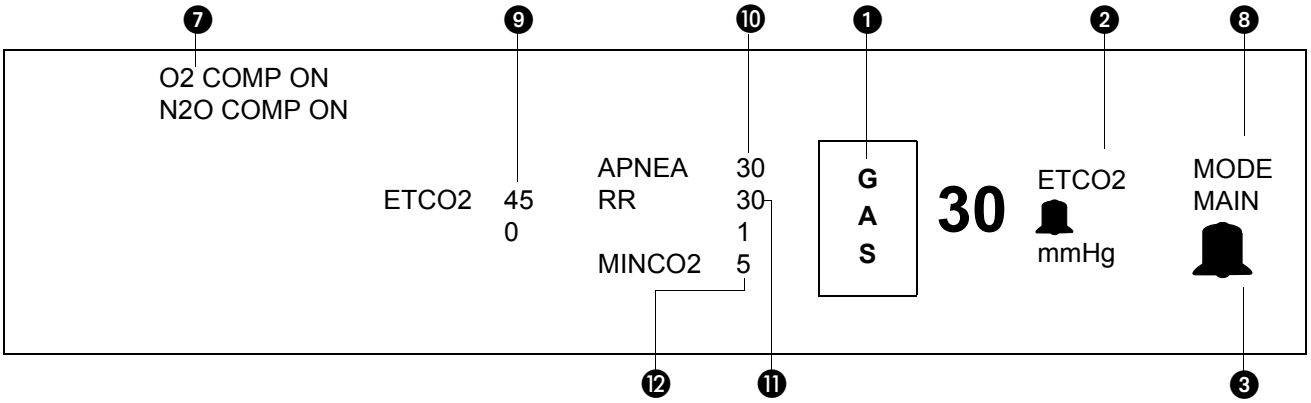



*Figure 23-9: Bedside monitor, LARGE NUM ONE ZONE, with VIEW ALARMS ON*

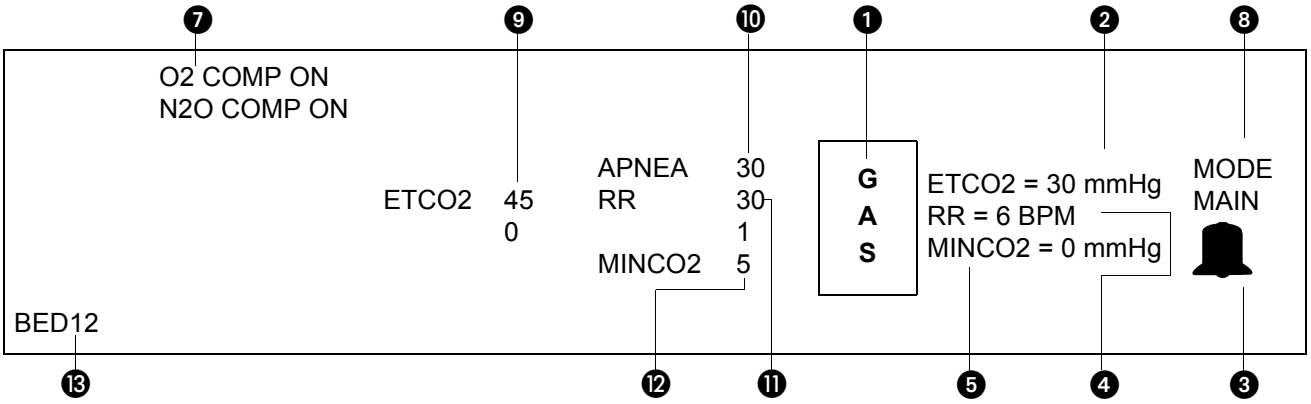



*Figure 23-10: Remote view, SMALL NUM ONE ZONE, with VIEW ALARMS ON*

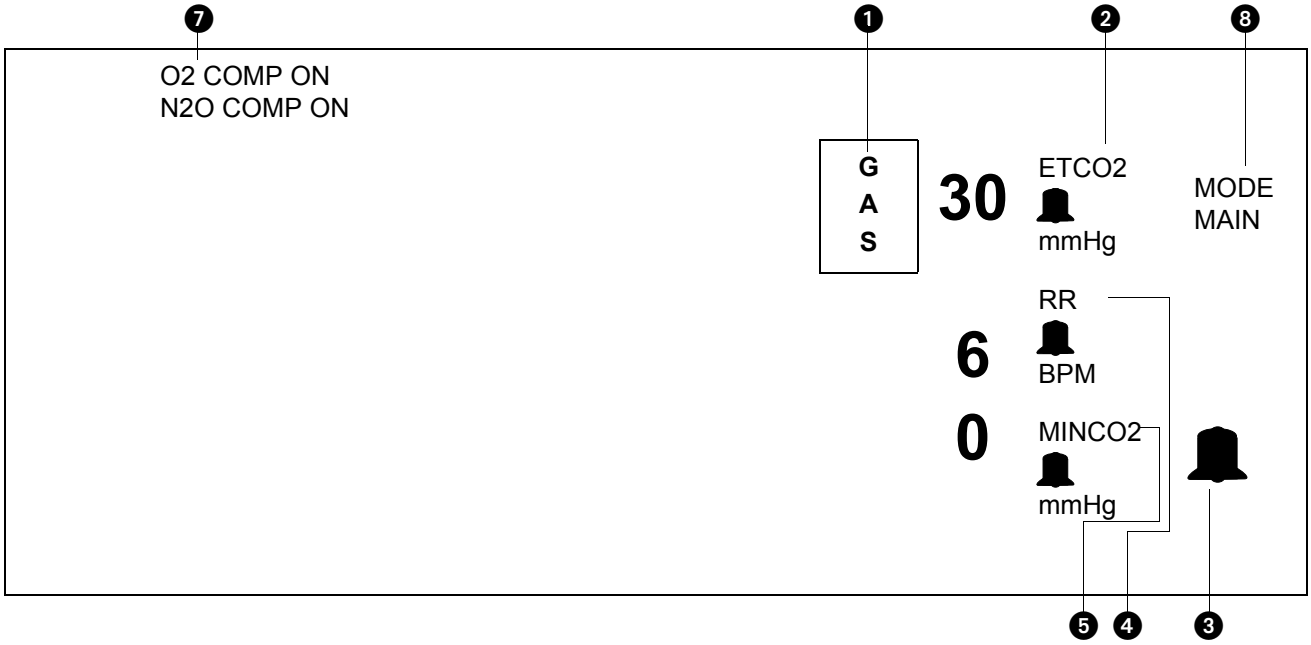



*Figure 23-11: Bedside monitor, LARGE NUM TWO ZONES (waveform OFF)*

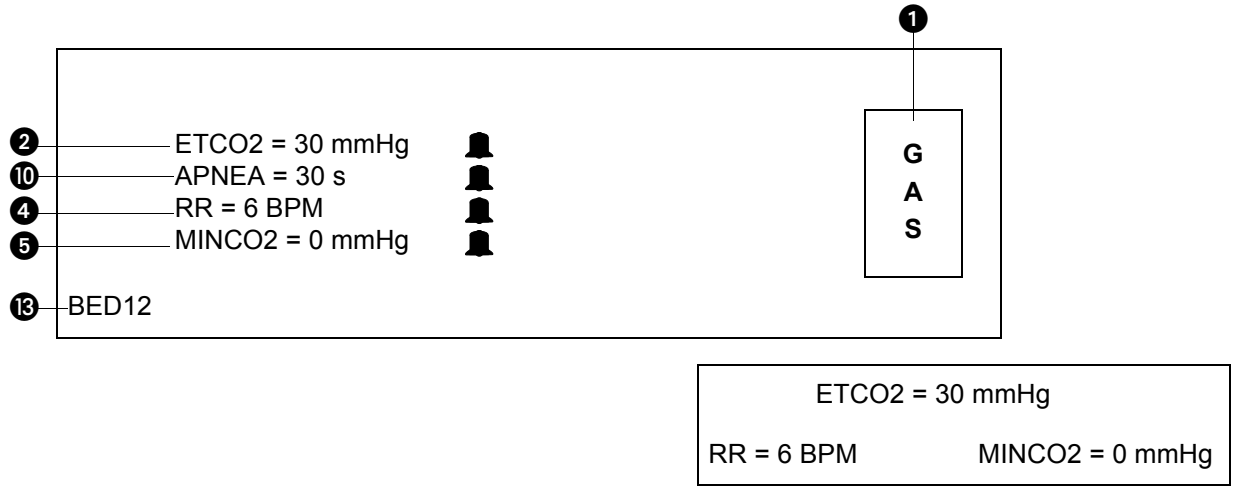



*Figure 23-12: Central monitor and numeric key*

1. GAS parameter key
2. End-tidal carbon dioxide data
3. Alarms status indicators (refer to *Table 1*)
4. Respiration rate
5. Minimum inspired carbon dioxide ($MinCO_2$) data
6. Waveform scale line
7. $O_2$ and $N_2O$ compensation statuses
8. Operational mode (MAIN or SIDE)
9. $EtCO_2$ alarm limits
10. Apnea alarm delay time (in seconds)
11. RR alarm limits
12. $MinCO_2$ alarm limit
13. Bed/patient ID

# Enabling and Adjusting Alarms

The module starts with no breath detected. All alarms are disabled until a respiratory rate is calculated following the detection of three continuous patient breaths.

The **Alarm Limits** menu allows you to enable and adjust alarm limits for respiratory rate (RR), $EtCO_2$, minimum $CO_2$ (high limit only), and the apnea alarm delay time. You can modify limits for any of the monitored parameters.

When the alarm is initially turned ON for $EtCO_2$ and RR, the alarm limit values depend on the patient's current readings for those parameters (these limit values are learned). Alarm limits for all other monitored parameters, when enabled, always have the same fixed values. You can adjust these limits up or down as needed.

**The capnography module has two special alarm features:**

- Alarms cannot occur until the capnography module detects that a patient is connected. Once alarms are enabled, any airway disconnect condition causes the capnography module to initiate the No Breath Detected alarm. This alarm only occurs if breathing is not detected for the defined apnea alarm limit setting duration (the apnea alarm does not need to be enabled).
- The capnography module's alarms normally end automatically when the underlying patient condition resolves. In some cases (such as disconnection of the $CO_2$ sensor), the capnography module cannot automatically end some alarms. When this occurs, touch the ACKNOWLEDGE ALARM key to end all alarms that can no longer be detected.

For additional information, refer to the *Alarms* section of the *Ultraview SL Module Configuration Manager System Administration Guide* (P/N 070-1245-xx).

**To enable and adjust alarm limits:**

1 Touch GAS.

2 Touch ALARM LIMITS.

3 Select a parameter.

4 Touch ON for the selected parameter.

5 Select the HI =, LO =, or APNEA = key.

6 Use the arrow keys to set the high and/or low alarm limits or the apnea alarm delay time.

7 Touch PREVIOUS MENU to select another parameter for setting alarm limits.

8 Repeat steps 3 through 7 until all limits are set.

***Note:***

*The APNEA and RR alarm selections include the following key:*

| APNEA |
|---|
| RR |

*This key allows the operator to toggle back and forth between the two respiratory rate-related alarm settings without having to return to previous menus.*

***Note:***

*The ETCO2 and MINCO2 alarm selections include the following key:*

| ETCO2 |
|---|
| MINCO2 |

*This key allows the operator to toggle back and forth between the two $CO_2$-related alarm settings without having to return to previous menus.*

*Table 1: Alarm Status Indicator*

| Alarm Status | Bell |
|---|---|
| At least one alarm ON | Present |
| At least one alarm ON and violated | Flashing |
| All alarms OFF | Replaced with GAS ALM OFF in reverse video |
| At least one alarm ON; alarms temporarily suspended by monitor | Replaced with GAS ALM SUSP in reverse video (flashes if any alarm is violated) |

# Waveform Settings

You can turn the capnography waveform OFF and display only the numeric values. When waveforms are OFF, the SWEEP SPEED key, the FREEZE ON/OFF key, the SCALE ON/OFF key, and the waveform size selection keys are grayed out.

If the waveform is too large to fit within the display zone, use the waveform size keys to adjust the size. The SCALES key enables you to display scale indications in the waveform zone that correspond to the current waveform size selection (refer to *Figure 23-7*).

You can freeze the waveform display by setting the FREEZE key to ON. When you freeze the waveform, numeric information continues to be updated. The waveform stays frozen until you touch FREEZE / OFF or touch the NORMAL SCREEN key.

The sweep speed determines the speed at which the waveform moves across the display. Available sweep speeds are 25, 12.5, 6.25, 3.12, or 1.56 mm/second.

**To turn the waveform display ON or OFF:**

- Touch GAS.
- Touch SETUP.
- Touch SIZE.
- Select WAVEFORM / ON or OFF.

**To adjust the waveform scale size:**

- Touch GAS.
- Touch SETUP.
- Touch SIZE.
- Select the desired scale size.

**To display the waveform scale on display:**

- Touch GAS.
- Touch SETUP.
- Touch SIZE.
- Select SCALE / ON.

**To freeze the waveform display:**

- Touch GAS.
- Select FREEZE / ON.

**To select a sweep speed:**

- Touch GAS.
- Touch SETUP.
- Touch SWEEP SPEED.
- Select the desired speed.

# Selecting a Unit of Measurement

You can monitor capnography values as a percentage or with the monitor's selected units of measurement for pressures (mmHg or kPa).

**To select a measurement unit:**

- Touch GAS.
- Touch SETUP.
- Select PERCENT or mmHg (kPa).

# Printing the Capnography Waveform

You can print capnography waveforms and values. Refer to *Printing* on page 9-5 for additional information.

**To print the gas waveform:**

- Touch RECORD.
- Touch the flashing GAS parameter key.

***Note:***

*Waveform printing and recording is available through compatible monitors and recorders/printers only.*

# Cleaning/Disinfecting

To clean the exteriors of monitors, modules, and cables, and for recommended cleaning materials and solutions, refer to *Cleaning, Disinfecting, and Sterilization* on page 33-1.

Questions and concerns about cleaning issues should be directed to a Spacelabs Healthcare field service engineer.

## $CO_2$ Sensors

The capnography sensor and cable should be cleaned routinely, especially between patient uses. Before cleaning, make sure the sensor is disconnected from the module and/or monitor. Sensors and cable assemblies should be wiped down using a cloth or swab dampened in 70% alcohol or 10% bleach solutions. Mild detergents may also be used initially to remove any residual buildup. Immediately after cleaning, wipe down sensors with distilled water and then dry to remove any cleaning residue.

**Caution:**

- **Under no circumstances should sensors be immersed in a solution of any type.**
- **Do not autoclave the sensor.**
- **Never use solvents, acetone, or abrasive cleaning agents.**
- **Do not force the sensor onto the airway adapter.**
- **Avoid undue stress on the sensor head and the cable.**

***Note:***

- *Keep the sensor container after unpacking. When not in use, disconnect the sensor from the module and/or monitor, clean it, and then place it into the container for safe keeping.*
- *Limit sensor exposure to cleaning agents to a maximum of 15 to 20 minutes. Longer intervals of exposure could produce a slight dulling of the original surface finish.*

Visually inspect the sensor, cable, and the airway adapters for any sign of physical damage. Verify that the plugs and connectors are in good working condition and that the pins and prongs are not bent. Use a cotton swab dampened with alcohol or a mild soap to carefully clean the windows of the sensor head and the calibration cells. Always remove any damaged or questionable sensor or airway adapter from service.

## Mainstream Reusable Adapters

### Reusable Adult Airway Adapter

- Clean the adult airway adapter (P/N 704-0002-xx) by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant or cold liquid sterilant (e.g., Cidex). It should then be rinsed with sterile water and dried.
- Sterilize the adult airway adapter by using either a steam autoclave or by using ETO (ethylene oxide) gas methods. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure that the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

### Reusable Neonatal Airway Adapter

- Clean the neonatal airway adapter (P/N 704-0003-xx) by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant or cold liquid sterilant (e.g., Cidex). It should then be rinsed with sterile water and dried.
- Sterilize the neonatal airway adapter using ETO (ethylene oxide) gas. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure that the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

## Mainstream Single Use Adapters

Treat all single-patient use airway adapters in accordance with institutional protocol for single-patient use items.

## Sidestream Sampling Lines

Sidestream sampling lines are single-patient use only. Treat them in accordance with institutional protocol for single-patient use items.

# Capnography Alarm Delays

*Table 2: Capnography Alarms*

| Alarm Setting | Range | Alarm Delay (Average) |
|---|---|---|
| Resp Rate High | 15 to 150 bpm | Less than 1 second |
| Resp Rate Low | 1 to 145 bpm | |
| Apnea | | Apnea delay time + 1 second |
| $ETCO_2$ High | 1 to 99 mmHg | Less than 1 second |
| $ETCO_2$ Low | 0 to 98 mmHg | |
| $MinCO_2$ High | 1 to 40 mmHg | |

# Capnography Troubleshooting Guide

**Caution:**

**Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

The capnography module displays status messages in the gas waveform zone and on the message line. Many of these messages also trigger an alarm, as indicated in the following table.

***Note:***

**An alarm only occurs if a patient is detected.*

| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **CO2 SENSOR WARMING UP -OR- CO2 SENSOR STABILIZING** | ■ Module or sensor was just plugged in. | ■ Allow up to 7 minutes for the sensor to warm-up and stabilize. If the sensor does not stabilize, replace it with a known good sensor. If the message continues to display, troubleshoot or return to Spacelabs Healthcare for repair. | ■ No |
| **CO2 SENSORS DISCONNECTED - Check sensor or replace** | ■ Both $CO_2$ sensors are disconnected or are defective. | ■ Connect mainstream or sidestream $CO_2$ sensor. Replace with a known good sensor. If the message continues to display, troubleshoot or return to Spacelabs Healthcare for repair. | ■ Yes* |

| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **MAIN CO2 SENSOR DISCONNECTED - Check sensor or replace** | ■ The module is attempting to switch to SIDESTREAM mode, but AUTO SIDE is set to OFF. | ■ Connect a known good mainstream $CO_2$ sensor. | ■ Yes* |
| | ■ MAINSTREAM mode is selected; mainstream $CO_2$ sensor is either disconnected or defective. | ■ Connect a known good sidestream sensor and then select SIDESTREAM mode instead. | |
| | ■ AUTO SIDE is set to OFF, and sidestream sensor is plugged in and no mainstream sensor is present. | ■ Set AUTO MAIN to ON and then connect a known good sidestream sensor. | |
| | ■ Possible corruption of EEPROM on Capnography Interface board. | ■ Disconnect sidestream sensor and connect a known good sidestream sensor, with AUTO SIDE set to ON.<br>■ If the problem persists, return to the factory for repair. | |

| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **SIDE CO2 SENSOR DISCONNECTED - Check sensor or replace** | ■ The module is attempting to switch to MAINSTREAM mode, but AUTO MAIN is set to OFF. | ■ Connect a known good sidestream $CO_2$ sensor. | ■ Yes* |
| | ■ SIDESTREAM mode is selected; sidestream $CO_2$ sensor is either disconnected or defective. | ■ Connect a known good mainstream sensor and then select MAINSTREAM mode instead. | |
| | ■ AUTO MAIN is set to OFF, and mainstream sensor is plugged in and no sidestream sensor is present. | ■ Set AUTO SIDE to ON and then connect a known good mainstream sensor. | |
| | ■ Possible corruption of EEPROM on Capnography Interface board. | ■ Disconnect mainstream sensor and connect a known good mainstream sensor, with AUTO MAIN set to ON. | |
| | | ■ If the problem persists, return to the factory for repair. | |
| **(MAIN or SIDE) SENSOR OVER TEMPERATURE - Check sensor or replace** | ■ The indicated $CO_2$ sensor is exposed to extreme heat. | ■ Check sensor or replace. | ■ Yes |
| | | ■ Remove the excessive heat source from the sensor. If the problem persists, return to the factory for repair. | |
| **FAULTY CO2 SENSOR - Check sensor or replace** | ■ The connected $CO_2$ sensor is faulty. | ■ Replace with a known good $CO_2$ sensor. If the problem persists, return to the factory for repair. | ■ Yes |
| **INCOMPATIBLE CO2 SENSOR - Check sensor or replace** | ■ An incompatible $CO_2$ sensor is connected. | ■ Replace with a compatible $CO_2$ sensor. | ■ Yes |

| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **CHECK CO2 AIRWAY ADAPTER - Perform adapter cal** | ■ Airway adapter was removed from the sensor head. | ■ Snap airway adapter back into the sensor head. | ■ Yes |
| | ■ Optical blockage on airway adapter windows. | ■ Clean or replace the airway adapter. | |
| | ■ Adapter calibration was not performed. | ■ Perform an airway adapter calibration. | |
| | ■ A general fault of the $CO_2$ adapter was detected. | ■ Place the sensor head and the airway adapter in room air and away from any source of $CO_2$ and perform an airway adapter calibration. If the problem persists, return to the factory for repair. | |
| **OCCLUSION OR LEAK - Remove and check sampling line** | ■ Either an occlusion (obstruction) or a leak was detected. | ■ Remove the sensor and clear the occlusion from the sampling line. Replace with a good sampling line, if needed. Reattach the sensor to start sampling again. | ■ Yes |
| | | ■ Check for blocked exhaust port or occluded gas scavenging line. Remove and reconnect sensor to resume sampling. | |
| **CO2 ZERO CAL IN PROGRESS** | ■ A zero calibration of the $CO_2$ sensor is in progress. | ■ Wait for the *CO2 ZERO CAL COMPLETED* message to appear. | ■ No |
| **CO2 ZERO CAL FAILURE** | ■ An error was detected during sensor zero calibration. | ■ Perform a zero and reference calibration. If the problem persists, replace with known good sensor and return faulty sensor to factory for repair. | ■ Yes |

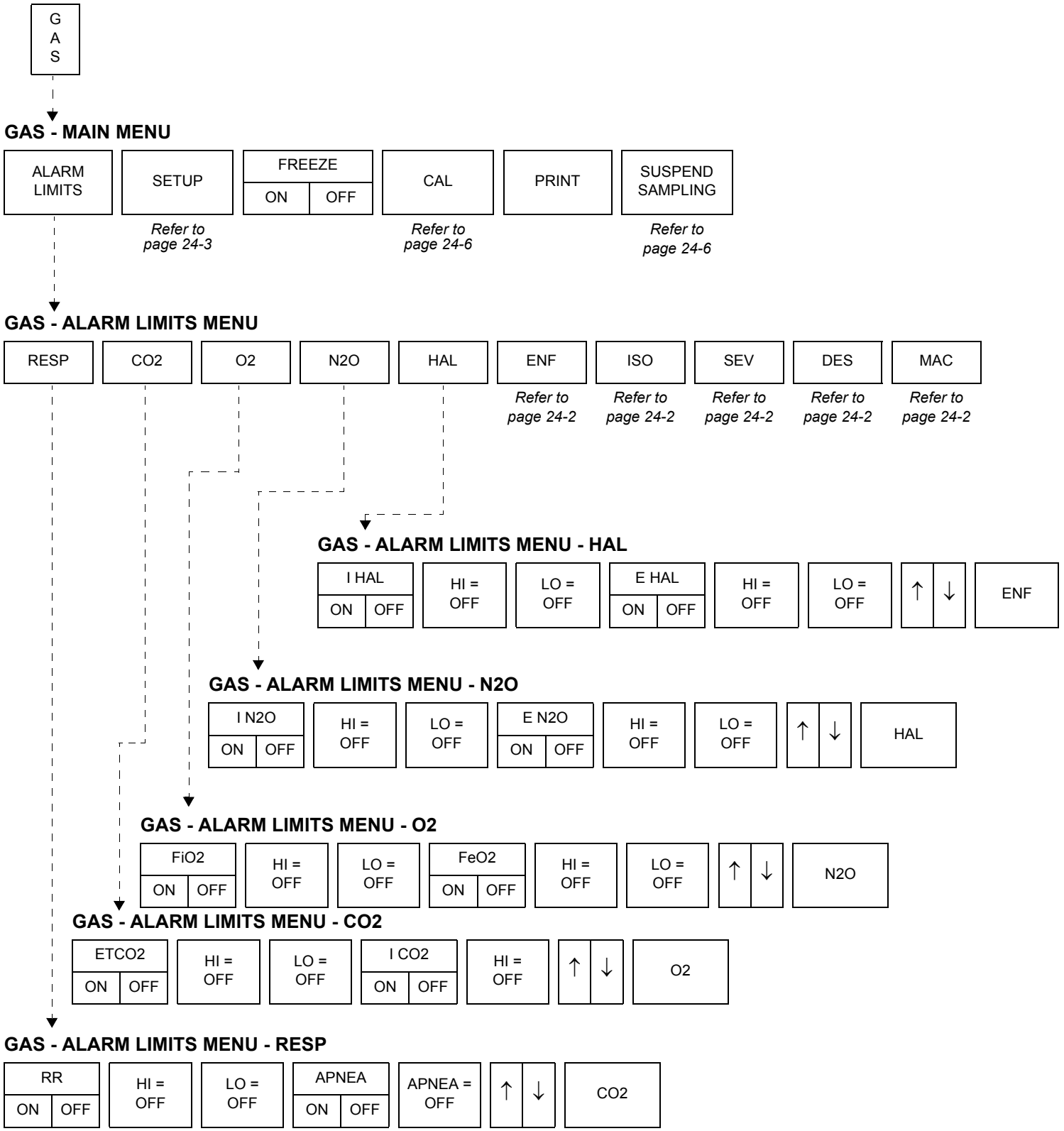
| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **CO2 ZERO CAL INCOMPLETE** | ■ Calibration could not proceed because the sensor is not ready. | ■ Wait for the message to disappear. | ■ No |
| **CO2 ZERO CAL COMPLETED - Place sensor on REF cell** | ■ A zero calibration of the $CO_2$ sensor was completed successfully. | ■ Remove the sensor head from the zero cell and place it over the reference cell. | ■ No |
| **CO2 REF CAL IN PROGRESS** | ■ A reference calibration of the $CO_2$ sensor is in progress. | ■ Wait for the *CO2 REF CAL COMPLETED* message to appear. | ■ No |
| **CO2 REF CAL FAILED** | ■ An error was detected during the sensor reference calibration. | ■ Perform a zero and a reference calibration. If the problem persists, return sensor to factory for repair. | ■ No |
| **CO2 REF CAL INCOMPLETE** | ■ Calibration could not proceed because the sensor is not ready. | ■ Wait for the message to disappear. | ■ No |
| **CO2 REF CAL COMPLETED** | ■ A reference calibration of the $CO_2$ sensor was completed successfully. | ■ Remove the sensor head from the reference cell and place it over the airway adapter. | ■ No |
| **CO2 ADAPTER CAL IN PROGRESS** | ■ A $CO_2$ adapter calibration is in progress. | ■ Appears while the adapter calibration is being performed. | ■ No |
| **CO2 ADAPTER CAL FAILED** | ■ $CO_2$ calibration sequence failed. | ■ Recalibrate the $CO_2$ adapter. If the problem persists, return to the factory for repair. | ■ Yes |
| **ADAPTER CAL INCOMPLETE - $CO_2$ sensor not ready** | ■ Calibration could not proceed because the sensor is not ready. | ■ Wait for the message to disappear. | ■ No |

| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **CO2 ADAPTER CAL COMPLETED** | ■ A $CO_2$ adapter calibration was completed successfully. | ■ Remove the sensor head from the reference cell and place it over the airway adapter. | ■ No |
| **SERVICE REQUIRED - Send for repair** | ■ Barometric pressure reading error.<br>■ Module self-test failure.<br>■ Invalid or corrupt EEPROM configuration detected. | ■ Return to the factory for repair. | ■ Yes |
| **COMMUNICATION LINK LOST - Service required -OR- COMMUNICATION DROP OUTS - Service required** | ■ An internal communication error was detected. | ■ Disconnect module, and then reconnect module.<br>■ Return to the factory for repair. | ■ Yes |
| **SERVICE CAL MODE - Patient is not monitored** | ■ **Service Calibration** menu is displayed. | ■ Touch NORMAL SCREEN to exit this mode. | ■ No |
| **NO BREATH DETECTED** | ■ Breaths are not detected for a duration equal to the APNEA timeout duration. | ■ Verify sensor is properly connected to the patient. Message will clear after three breaths are detected. | ■ Yes |
| **Low or high $CO_2$ values are observed** | ■ An airway adapter and/or sensor calibration is needed. | ■ Perform a zero and a reference calibration, make sure the appropriate airway adapter is selected and perform an airway adapter calibration. If the problem persists, return to the factory for repair. | ■ No |

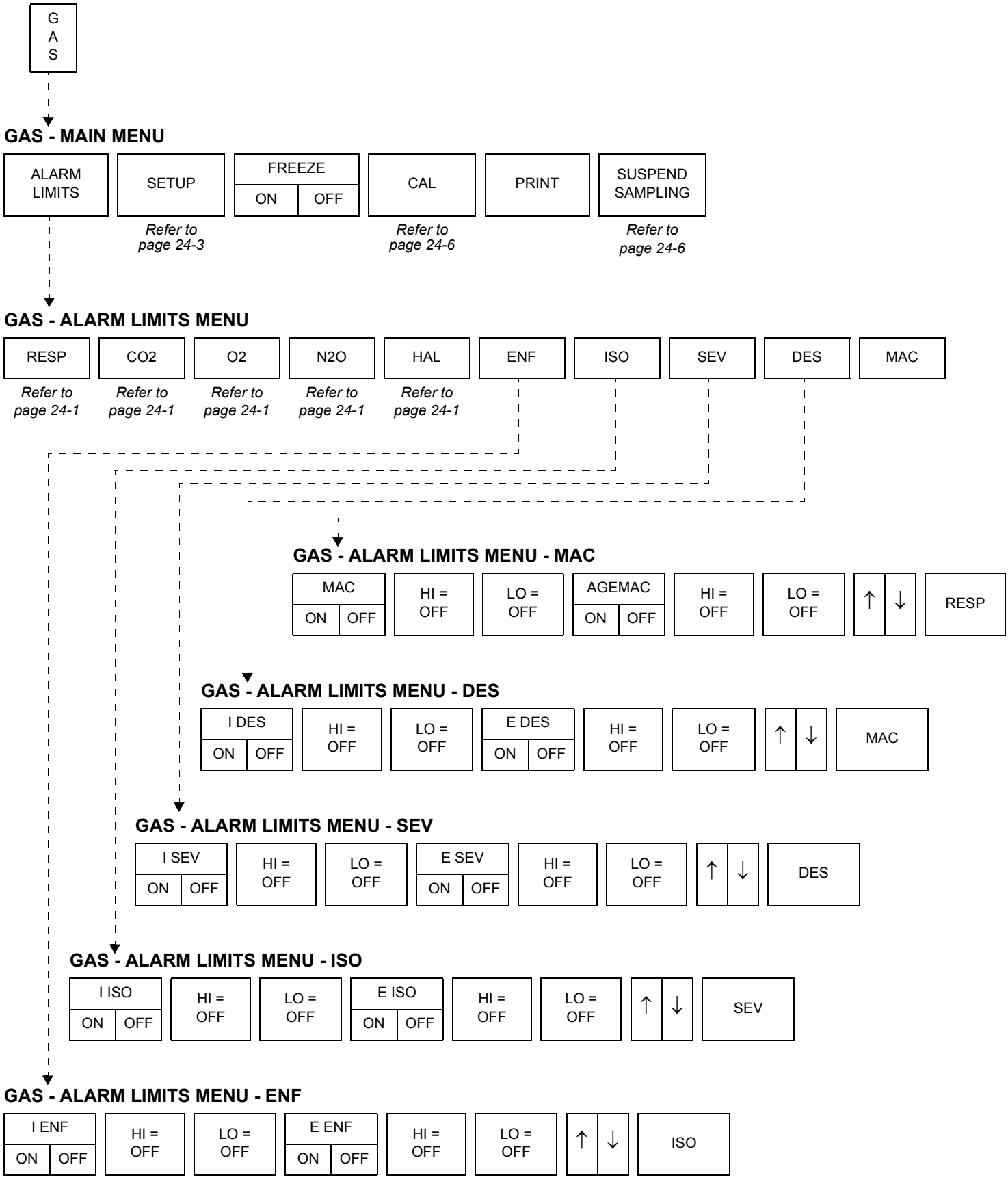
| Problem or Message | Probable Cause(s) | Suggested Response | Alarm Sounds |
|---|---|---|---|
| **$CO_2$ sampling suspended** | ■ The SUSPEND CO2 button was pressed. | ■ Touch GAS, touch, SETUP, touch OPERATION MODE, then touch RESUME CO2. | ■ No |

# Multigas (91518)

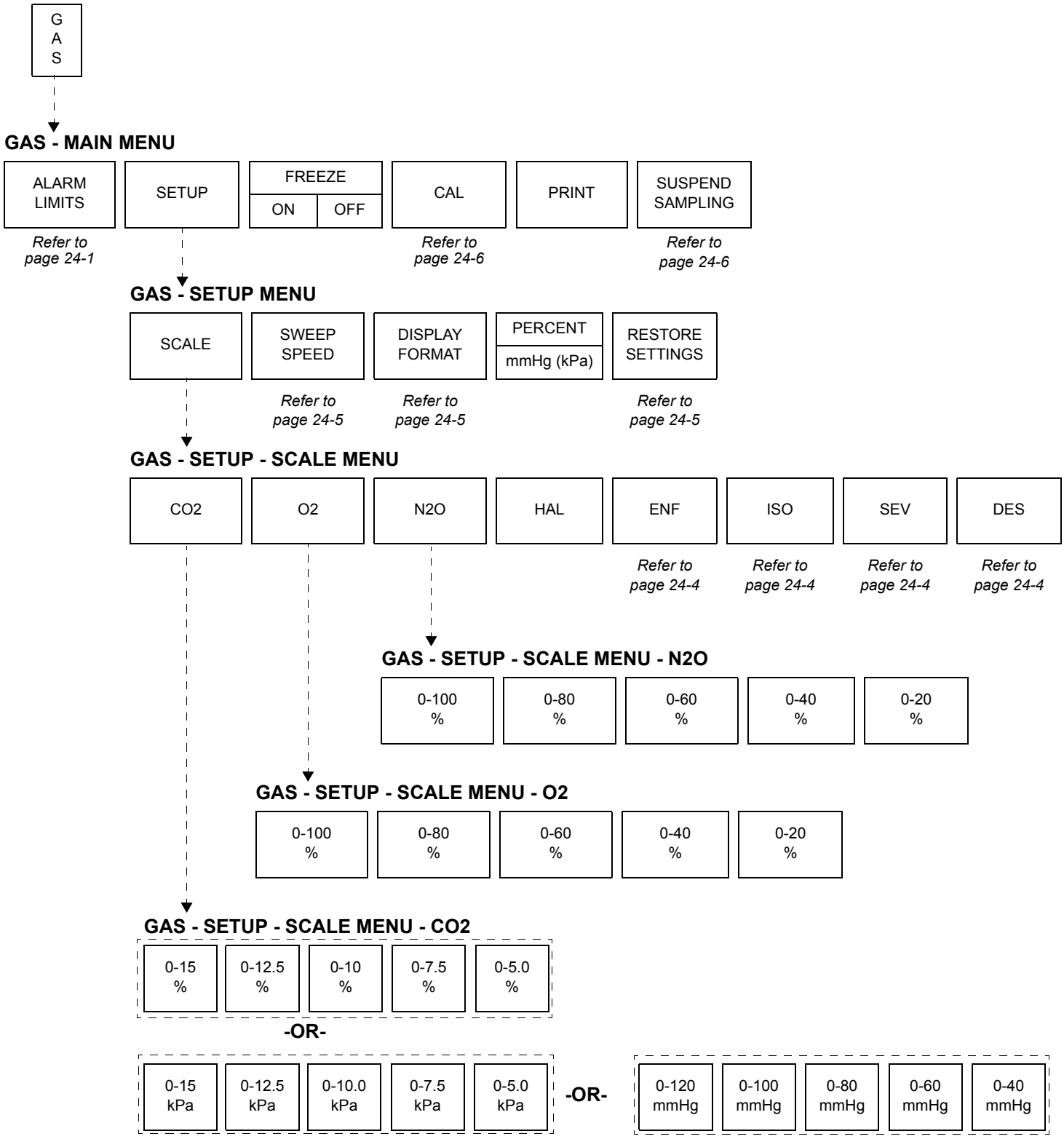
## Directory of Keys



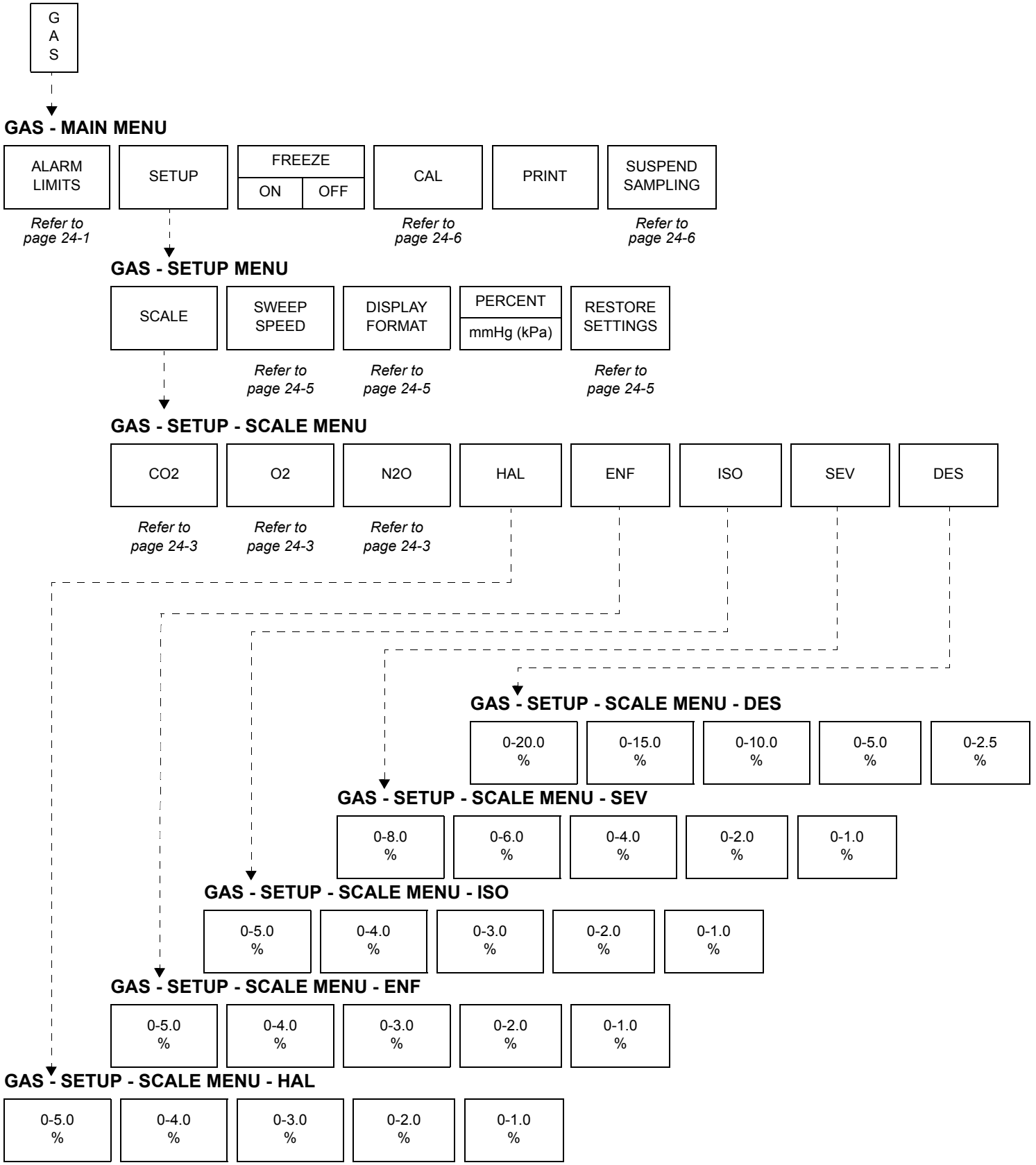
## Alarm Limits (continued)



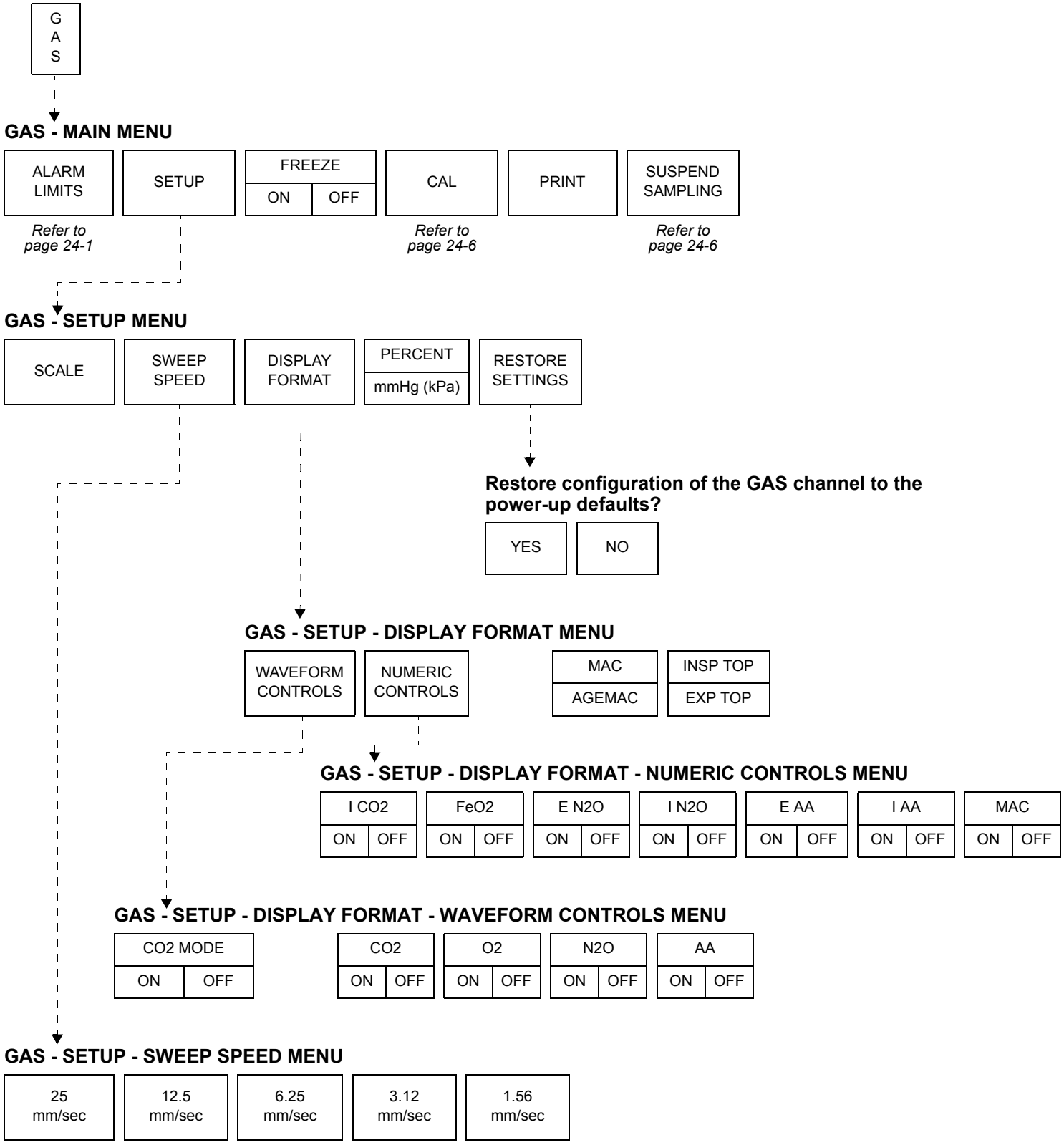
# SETUP - SCALE MENU



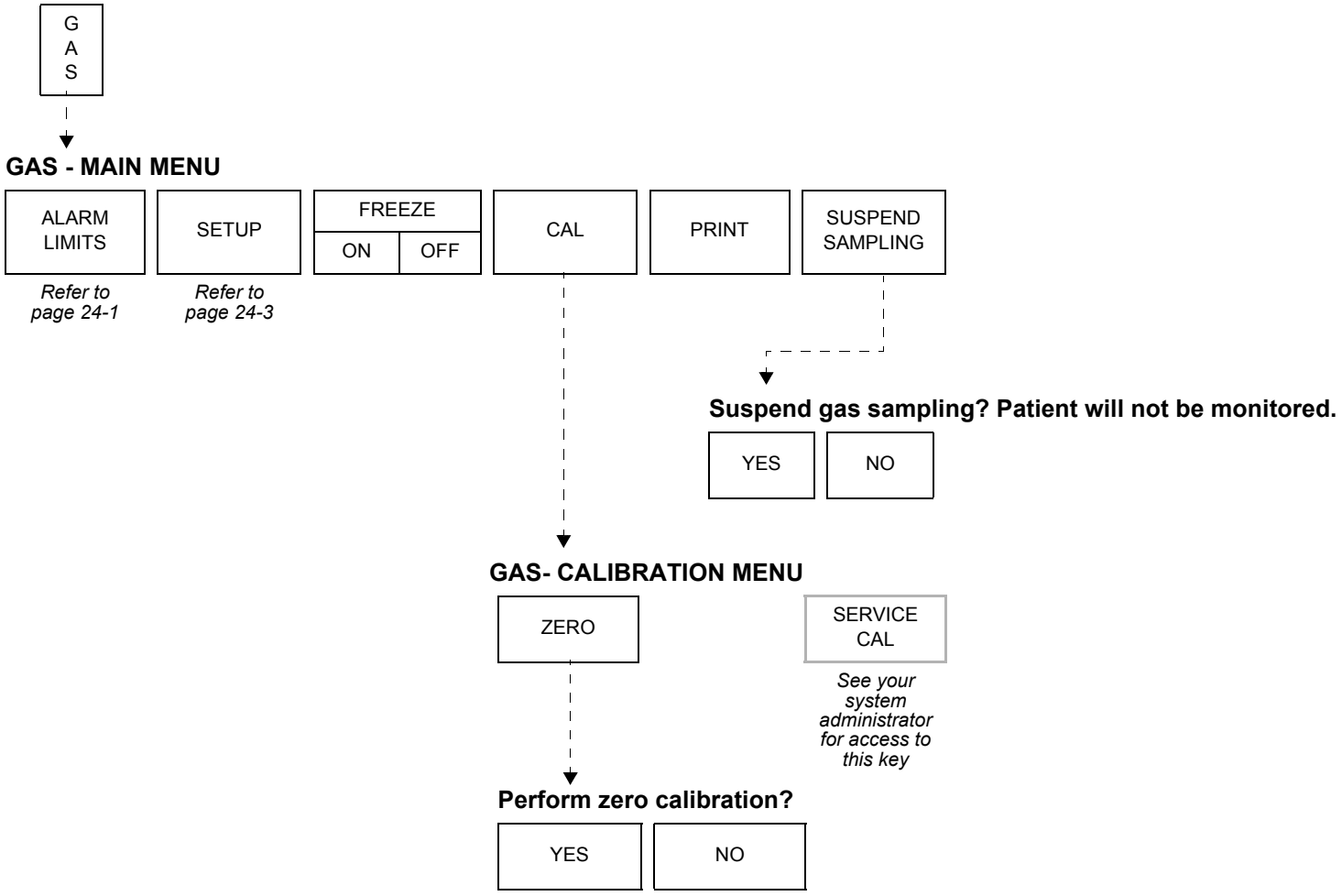
# SETUP - SCALE MENU (continued)



## SETUP (continued)



# GAS - MAIN MENU (continued)



# Multigas (91518)

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## Overview

The Spacelabs Healthcare Multigas Analyzer is a sidestream analyzer that simultaneously monitors gas concentrations and alerts clinical personnel when the concentration of anesthetic agents, oxygen ($O_2$), carbon dioxide ($CO_2$), or nitrous oxide ($N_2O$) falls outside the defined limits. The anesthetic agent being administered is automatically identified.

## Indications for Use

The Spacelabs Healthcare 91518 Multigas Analyzer provides a means to monitor a variety of gas concentrations and alert clinical personnel when the concentration of anesthetic agent(s), oxygen, carbon dioxide, or nitrous oxide falls outside of user-defined limits. The Multigas Analyzer is capable of automatically identifying which anesthetic agent(s) is being administered.

The 91518 Multigas Analyzer is intended to be used with, and is controlled by, a Spacelabs Healthcare Ultraview family monitor. Refer to *Compatibility* on page 24-9.

The 91518 Multigas Analyzer is intended to be used for monitoring all hospitalized patients, under the direction of qualified medical personnel.

The 91518 is a sidestream multigas analyzer that diverts patient gases at a flow rate of 200 ml/min.

**Caution:**

**The 91518 multigas analyzer is not intended to be a primary diagnostic apnea monitor.**

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to the 91518 Multigas Analyzer. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to several physiological parameters or to the monitoring system itself.

## Warnings

The life or health of a patient, clinical staff members, or other persons may be endangered if the warnings in this section are not followed.

***Warning:***

- ***Always verify that all sampling line adapter connections are tight, and verify proper operation before attaching the sampling line to a patient.***
- ***Connect the multigas analyzer's sample gas outlet to the hospital scavenging system to prevent pollution of the room air.***
- ***To protect against electrical shock, always power OFF and unplug the multigas analyzer before cleaning it.***
- ***To avoid explosion hazards, flammable anesthetic agents, such as ether and cyclopropane, must not be used in the multigas analyzer.***
- ***Only halothane (HAL), enflurane (ENF), isoflurane (ISO), sevoflurane (SEV), and desflurane (DES) are suitable for use. If any other halogenated anesthetic agent is present, it will be misidentified and/or will interfere with the reported anesthetic agent concentrations.***
- ***The use of antistatic or electrically conductive breathing tubes when using high-frequency electrosurgery equipment may increase the risk of burns and is, therefore, not recommended in any application of the multigas analyzer.***
- ***The multigas analyzer is not intended for use in an MRI environment.***
- ***Operation outside the specified values may cause inaccurate results.***

## Cautions

Equipment may be damaged or cease to function properly if the cautions in this section are not followed.

**Caution:**

- **When administering anesthetic agents, incorrect agent identification may occur when a mixture of more than two anesthetic agents occurs in the sample circuit.**
- **Always verify your vaporizer setting when administering anesthetic agents.**

- **Use only Spacelabs Healthcare sampling lines and accessories. Other sampling lines may cause inaccurate readings and malfunctions. The multigas analyzer must use a sampling line that is fabricated from a special material. Use of other sampling lines may result in erroneous readings.**
- **The diameter of the scavenging system line must be two to three times larger than the sampling line tubing to avoid changes in the operating pressure of the multigas analyzer and consequential inaccurate readings or internal damage.**
- **Route the scavenger hose so that it does not kink during operation of the monitor. A kinked or partially kinked scavenger hose will impair performance of the multigas analyzer.**
- **If the patient's airway is configured with a closed suctioning system, the airway adapter must be placed near the suctioning system (on the ventilator side). This helps ensure that the sampling adapter is not impaired during and after suctioning.**
- **Check the disposable water trap regularly during monitoring. Empty the water trap when more than half full.**

***Note:***

- *The 91518 Multigas Analyzer uses either a black or green-colored D-fend water trap.*
- *The black D-fend water trap is disposable but it is not restricted for single-patient use. Replace the black D-fend water traps at least every two months, or when an OCCLUSION – CHECK SYSTEM message or CHECK OR REPLACE WATER TRAP message persists.*
- *The green D-fend+ water trap is used with patients with extensive mucus secretion or in high-humidity conditions, and is for single-patient use only. Replace the green D-fend+ water trap every 24 hours, or when an OCCLUSION – CHECK SYSTEM message or CHECK OR REPLACE WATER TRAP message persists.*
- *The Spacelabs Healthcare sampling lines are for single-patient use only. Cleaning deteriorates the properties of the sampling line, resulting in slower response time and more frequent occlusions. Between patients, replace the sampling lines.*
- *Before you administer nebulized drugs to a patient connected to the multigas analyzer, disconnect the sampling line from the patient or stop the pump by touching the SUSPEND SAMPLING key.*
- *To facilitate disconnecting and reconnecting the sampling line, use a T-connector in the patient airway circuit and keep sampling suspended until all nebulized drugs have cleared from the patient's airway.*

# 91518 Multigas Setup

Refer to the *Multigas Analyzer Service Manual* (P/N 070-1328-xx) for instructions on connecting the analyzer to a Spacelabs Healthcare monitor.

## Compatibility

The 91518 Multigas Analyzer is designed for use with Ultraview SL, Ultraview, and UCW monitors. Some UCW (S/N below 385-3xxxxx) and Ultraview monitors (S/N below 387-1xxxxx) do not support all waveforms and display options, such as colors.

The following monitors are not supported: Ultracare SLP100, PC1 (90303), PC2 (90305), PCX (90308), and PC Scout® (90309).

If more zones are selected than are available, the GAS key appears at the bottom of the display, in the numeric key zone. When you touch the GAS numeric key, the GAS parameter is displayed in the lowest-priority display zone.

When monitoring gas concentrations on a monitor limited to three or four waveforms, the GAS parameter should be set to display only one or two zones.




*Figure 24-1: Multigas analyzer front panel controls and features*

1. Sample port
2. Water trap
3. Oxygen reference gas port
4. Power switch
5. Gas scavenging port

# Patient Connection

Respiration can be monitored via a gas sampling T and anesthesia mask or an endotracheal or tracheostomy tube. There are several variations of closed-circuit tracheal suction systems that can be used with Spacelabs Healthcare multigas analyzers.

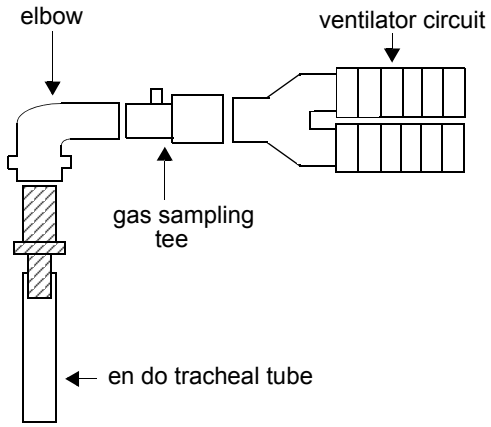



*Figure 24-2: Example of sidestream multigas setup for an adult*

The sampling line must be connected to the water trap and to the patient circuit. For ease of connection, you can connect the sampling line to the water trap prior to the insertion of the water trap into the multigas analyzer.

Prior to connecting to the patient airway, verify that there are no leaks in the sampling line or water trap by sealing the end of the sampling line with your thumb. After approximately 15 seconds, the OCCLUSION message should display on the monitor. If this does not occur within 30 seconds, check for an air leak by removing and carefully reinstalling the water trap and/or the sampling line. Repeat the test.

***Warning:***

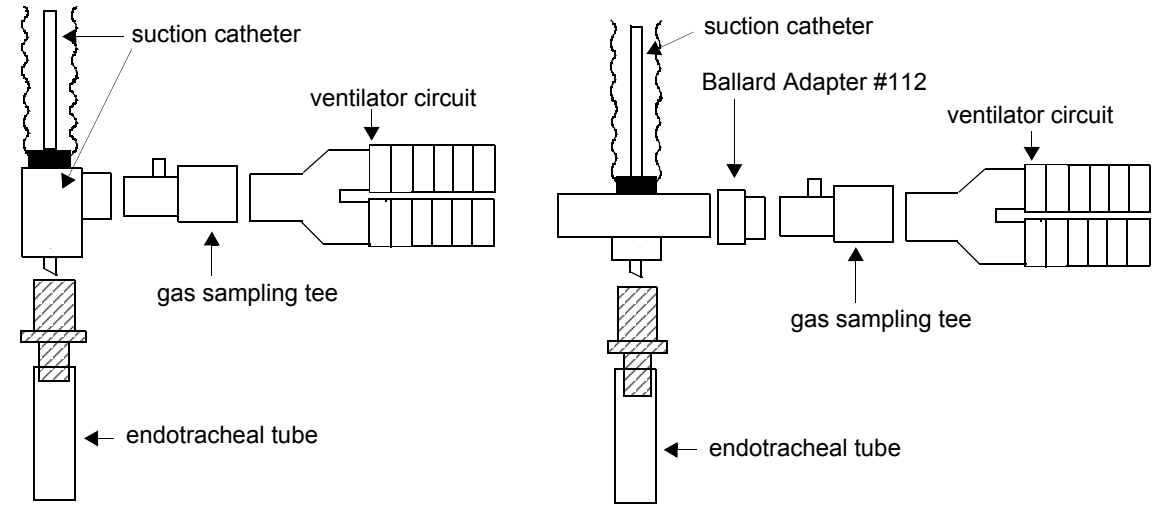
***Always verify the sampling line adapter's tight connection and proper operation of the multigas analyzer before attaching to a patient.***

## Closed-Circuit Tracheal Suction Systems

Closed-circuit tracheal suction systems (such as those provided by Ballard) extend the life of the endotracheal tube and associated tubing by allowing the endotracheal tube to be periodically suctioned without detaching it from the ventilator circuit. Spacelabs Healthcare recommends the use of Ballard Model 221 elbow closed-circuit tracheal suction systems, or similar systems, with its capnography modules and multigas analyzers. Such a system enables the gas sampling tee to be placed outside the tube through which fluids are being suctioned, reducing the chance of occluding the airway.

Spacelabs Healthcare does not recommend using traditional setups that require the airway adapter to be in-line with the endotracheal tube. However, if you prefer a traditional setup, such as the Ballard Model 2205 style, use the Ballard Model 112 adapter to move the airway adapter away from the suction catheter.

*Figure 24-3* shows examples of setups using the Ballard Model 221 and Model 2205 styles (with Model 112 adapter). Similar closed systems, such as the Concord Portex (not shown), must be placed in the ventilator circuit in the same positions as shown in *Figure 24-3*.




**Ballard elbow closed tracheal suction system (Model 221)** **-OR-** **Ballard closed tracheal suction system with adapter (Model 2205/Adapter #112)**

*Figure 24-3: Ballard setups*

# Operation

$CO_2$, $N_2O$, and anesthetic agents are measured by drawing a sample gas stream into the measuring chamber. The multigas analyzer uses nondispersive infrared radiation to measure the absorption of the gas sample at seven infrared wavelengths, which are selected using optical narrow band filters. The infrared radiation detectors are thermopiles.

Concentrations of $CO_2$ and $N_2O$ are calculated from absorption measured at 3 to 5 µm. Identification of anesthetic agents and calculation of their concentrations is performed by measuring absorptions at five wavelengths from 8 to 9 µm, and by solving a set of five equations. Measurement accuracy is achieved through software compensation.

***Warning:***

***Only halothane (HAL), enflurane (ENF), isoflurane (ISO), sevoflurane (SEV), and desflurane (DES) are suitable for use with the multigas analyzer. If any other halogenated anesthetic agent is present, it will be misidentified and/or will interfere with the reported anesthetic agent concentrations.***

**Caution:**

- **Caregivers should account for the 200 ml/min sampling rate when working with low volume capacity patients.**
- **When administering anesthetic agents, incorrect agent identification may occur when a mixture of more than two anesthetic agents occurs in the sample circuit.**
- **Always verify your vaporizer setting when administering anesthetic agents.**

$O_2$ concentration is measured with a paramagnetic oxygen sensor. The sensor uses a differential pressure transducer to compare the pressure gradient produced when reference and sample input gases are exposed to an oscillating magnetic field.

Because this method of measurement has a fast response time, inspired and expired values of $O_2$ can be reported. A sidestream sampling technique is used to acquire respiratory gases from an endotracheal or tracheostomy tube or anesthesia mask. A constant-flow vacuum system maintains the flow rate through the sampling line.

The multigas analyzer is equipped with a disposable, external D-fend water trap to prevent humidity, water drops, and patient secretions from contaminating the unit or affecting the accuracy of the gas measurements. The D-fend water trap collects water droplets that condense in the sampling line.

*CHECK OR REPLACE WATER TRAP* message warns you that the water trap should be emptied or replaced.

**Caution:**

- **The multigas analyzer cannot be operated without a water trap installed.**
- **Replace the water trap as needed. Verify that the water trap is not broken as a result of connecting the sampling line fitting too tightly or by tugging on the sampling line. To verify, place a finger over the end of the sampling line and wait for the *OCCLUSION* message. Check the sampling line connection on the water trap for damage. A broken water trap results in low values, because the sample is mixing with room air. If a calibration is performed with a broken water trap, patient values will be unusually high. Refer to Calibrations on page 24-30 and Replacing/Emptying the Water Trap on page 24-15 for details.**

***Note:***

- *Check the disposable water trap regularly during monitoring. Empty the water trap when it is more than half full.*
- *Between patients, replace the sampling line. Replace the green D-fend+ water trap at least every 24 hours. Replace the black D-fend water trap at least every two months.*

The multigas analyzer automatically compensates for the ambient barometric pressure to ensure accurate readings. Both $CO_2$ values may appear in partial pressure (in mmHg or kPa) or in percent (%).

$$\%\ \text{Gas} = \frac{\text{PARTIAL PRESSURE GAS}}{\text{BAROMETRIC PRESSURE}} \times 100\%$$

***Note:***

*Respiration rate and alarm limit accuracies are not specified above 60 breaths per minute.*

## Powering ON the Unit

Before powering the multigas analyzer ON, make sure it is connected to a monitor. The monitor must be powered ON prior to powering ON the multigas analyzer. Press the blue power ON/OFF button located on the front of the multigas analyzer.

**Caution:**

**If the multigas analyzer is powered ON before the monitor, communication may not be initiated. Make sure the bedside monitor is powered ON before the multigas analyzer.**

When you first power ON a properly installed multigas analyzer, the center of the power-ON button illuminates. Within 30 seconds, the monitor displays the GAS parameter key to the right of a flat waveform.

If this does not occur, verify that the power ON/OFF button is pressed and illuminated. The multigas analyzer must be connected to an AC power outlet. Check that the SDLC switch on the back panel of the multigas analyzer is in the correct position. Verify that the appropriate SDLC cable and terminator are connected to the monitor (refer to the *91518 Multigas Analyzer Service Manual,* P/N 070-1328-xx). If the monitor or the module housing has an SDLC switch, check that the switch is in the correct position. If the GAS parameter key does not display on the monitor, power OFF the multigas analyzer, and then power OFF the monitor. Power ON the monitor again, and then power ON the multigas analyzer again.

***Note:***

*The multigas analyzer is protected against the effects of a cardiac defibrillation discharge, and it is safe to use on patients with a cardiac pacemaker or other electrical stimulation.*

**To start multigas monitoring when the unit is OFF:**

- Plug the device power cord into an AC power outlet and ensure that the multigas analyzer is connected to a monitor.
- Connect the sampling line to the sample port on the water trap. Do not overtighten the sampling line.
- Ensure that the ON/OFF switch on the multigas analyzer is OFF (not illuminated).
- Power ON the monitor.
- Power ON the multigas analyzer (press the blue ON/OFF switch on the front of the unit).
- Prepare the patient according to hospital procedures.
- Allow the multigas analyzer to warm up for a minimum of 2 minutes for $CO_2$, $O_2$, and $N_2O$ detection. Allow the multigas analyzer to warm up for 5 minutes for agent detection. Full accuracy is achieved after 30 minutes.
- Check that the water trap is fully inserted.
- Check the sample line for leaks.
- Connect the other end of the gas sampling line to the gas sampling tee or breathing circuit.
- During the use of anesthetic agents, ensure that the hospital scavenging line is connected to the scavenger port on multigas analyzer.

## Initialization

When the multigas analyzer is powered ON, the message *SENSOR WARMING UP* will display in the waveform zone for up to two minutes.

After the sensor warms up, the *GAS - AGENT WARMING UP* message displays on the prompt line for an additional 3 minutes.

After the warm-up periods, the *GAS - SENSOR STABILIZING* message displays on the prompt line for approximately 25 minutes.

During the warm-up and stabilization periods, the multigas analyzer may display one or more *AUTO ZERO IN PROGRESS* messages while it is performing automatic calibrations.

**Caution:**

- **The warm-up period for the multigas analyzer is less than two minutes for $CO_2$, $O_2$, and $N_2O$, and up to five minutes for anesthetic agents. The multigas analyzer reaches full accuracy after 30 minutes. You may use the multigas analyzer prior to full warm-up, but be aware of possible inaccuracies in gas analysis.**
- **When the multigas analyzer is powered ON, all default settings will be re-established. Any modifications made to the default settings (alarm limits, text display, etc.) prior to interruption of power will be lost.**

# Replacing/Emptying the Water Trap

The 91518 Multigas Analyzer uses either a black or green-colored D-fend water trap.

Replace the green water trap every 24 hours, or when occluded.

Replace the black water trap at least every two months, or when occluded.

**To remove the water trap:**

- Remove the sampling line, if attached.
- Press the release lever on the water trap. The water trap releases from the assembly.
- Pull the water trap away from the assembly.
- Dispose of the used water trap if occluded or if it is beyond its useful life.

***Warning:***

***The used water trap and sampling line may contain hazardous biological fluids and should be disposed of in accordance with hospital procedures.***

**To install a new water trap:**

- Connect the sampling line to the water trap. Do not overtighten.
- Insert the water trap into the assembly. You will hear a click when the water trap is inserted correctly.

***Note:***

*If the water trap is not fully seated, a LEAK DETECTED - CHECK SYSTEM message may occur when monitoring a patient.*

**To empty the water trap container:**

- Remove the water trap.
- Carefully pull downward on the water trap container until it releases from the water trap cartridge.
- Empty and clean the container.
- Insert the water trap container into the water trap cartridge. Ensure that the cartridge and container fit tightly together.
- Insert the water trap into the assembly. You will hear a click when the water trap is correctly inserted.
- If the sampling pump has stopped, touch the GAS key and then touch the RESUME SAMPLING key to restart monitoring.
- Verify that the occlusion or leak message disappears.

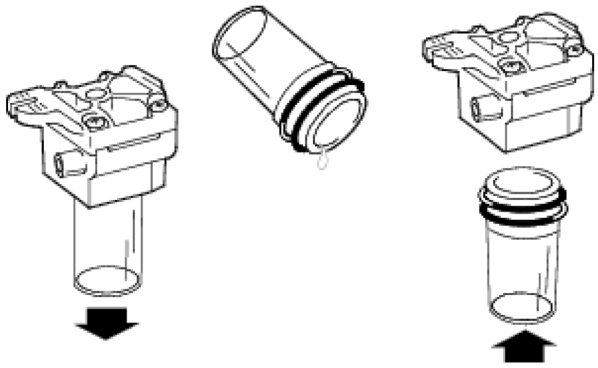


*Figure 24-4: Emptying the water trap container*

## Cleaning the Water Trap Container

The water trap container can be cleaned with disinfecting solutions or sterilized using cold chemicals or ethylene oxide.

### Caution:

**Do not disinfect or open the water trap cartridge. Do not touch the water trap membrane. The hydrophobic membrane in the water trap will be damaged if any cleaning is attempted, other than rinsing it with water.**

**To extend the life of the monitor, and to minimize monitor downtime:**

- Empty the water trap container when it is more than half full.
- Do not open, wash, or sterilize the water trap cartridge.
- After washing or disinfecting the water trap container, ensure there are no traces of alcohol or detergent left. Traces of alcohol or other organic cleaning solutions may affect measurements.
- Do not force air or oxygen through the water trap.

- Do not allow smoke or dust to enter the water trap.
- When administering nebulized medication, disconnect the gas sampling line from the patient circuit for 30 minutes.

# Patient Monitoring

Some Spacelabs Healthcare monitors support Start Case/End Case functions. When available, touch START CASE on the monitor to begin patient monitoring.

When using the analyzer with monitors that do not support Start Case/End Case, power the analyzer ON, then wait for initialization to complete. Patient monitoring begins when initialization is complete.

When a case has been ended by touching END CASE on the monitor, all alarms are deactivated, the multigas analyzer's sampling pump is turned OFF, and the multigas analyzer automatically enters suspended sampling mode.

The analyzer remains warmed up so that no additional warm-up time is required when you resume patient monitoring. Touch the START CASE or RESUME SAMPLING key to resume monitoring (refer to *Suspending and Resuming Sampling* on page 24-29).

# Display Detail

When you first connect the multigas analyzer to a monitor, the GAS parameter key displays to the right of a flat waveform.

Some display formats may be unavailable on some Spacelabs monitors. Refer to *Compatibility* on page 24-9.

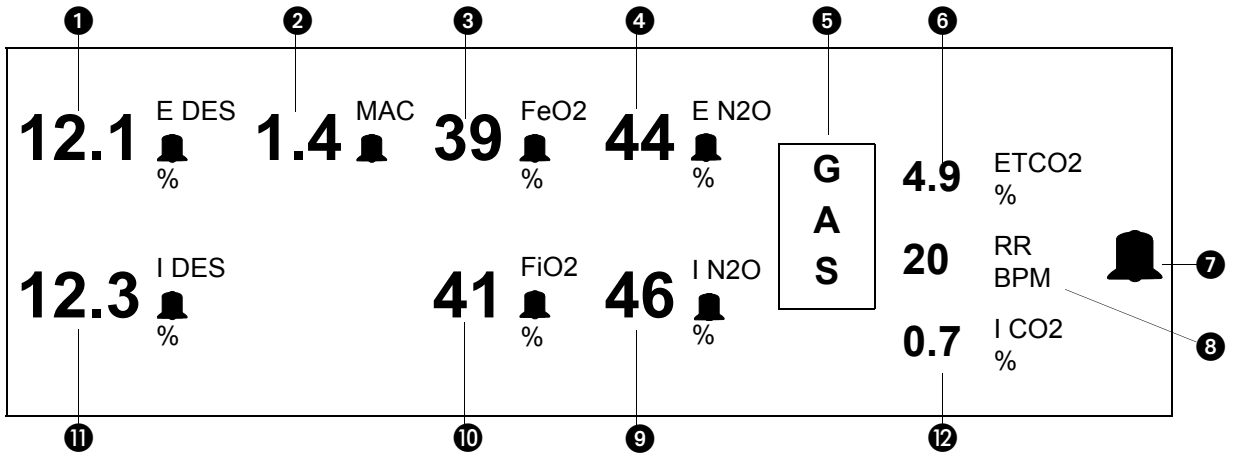



*Figure 24-5: Bedside display (one zone)*

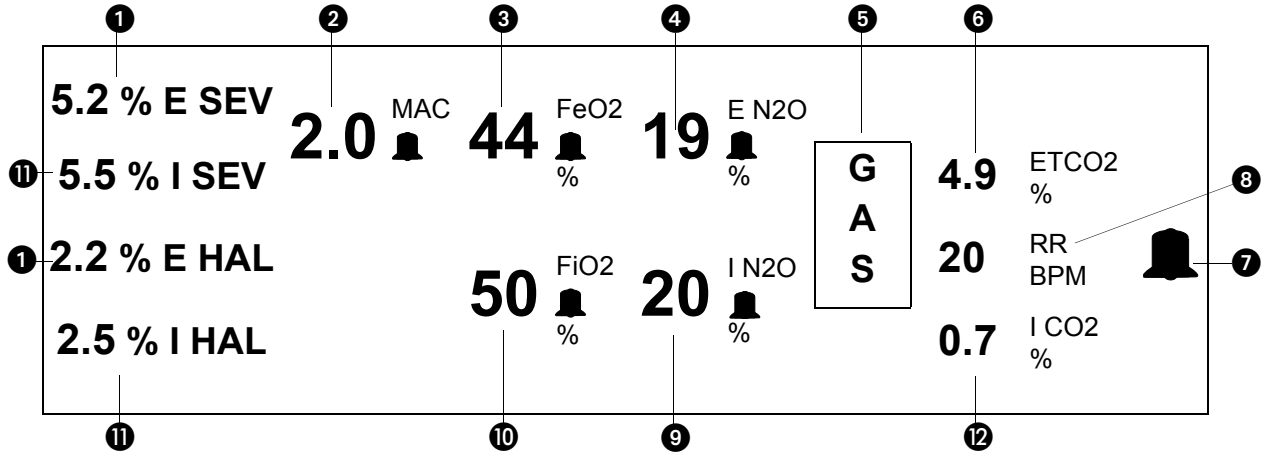



*Figure 24-6: Bedside display (one zone), two anesthetic agents*

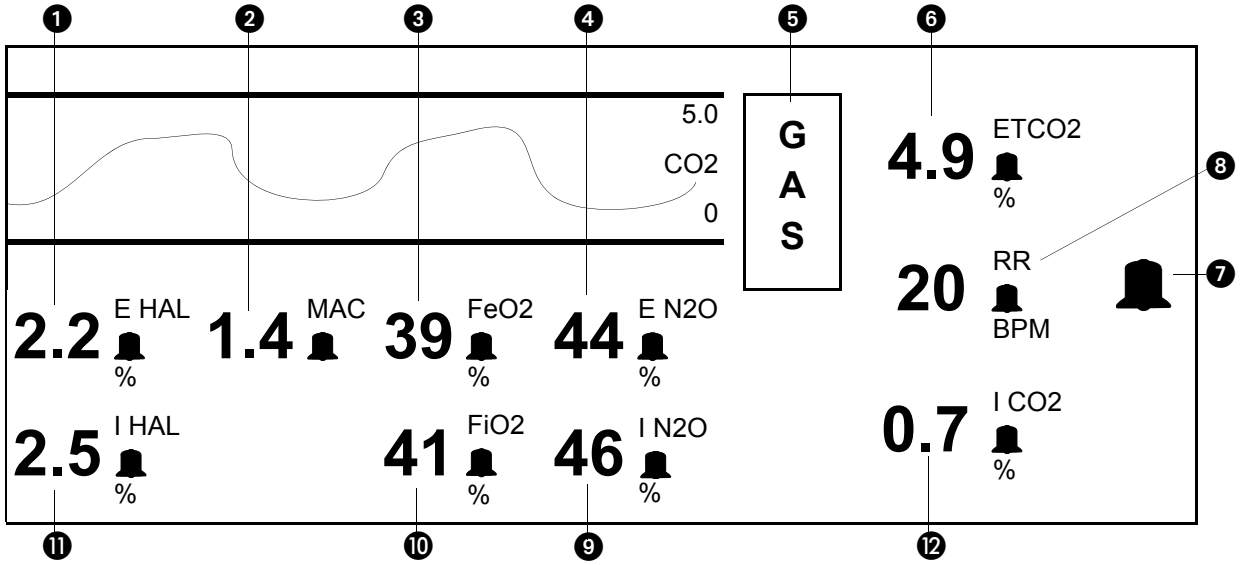



*Figure 24-7: Bedside display (two zones)*

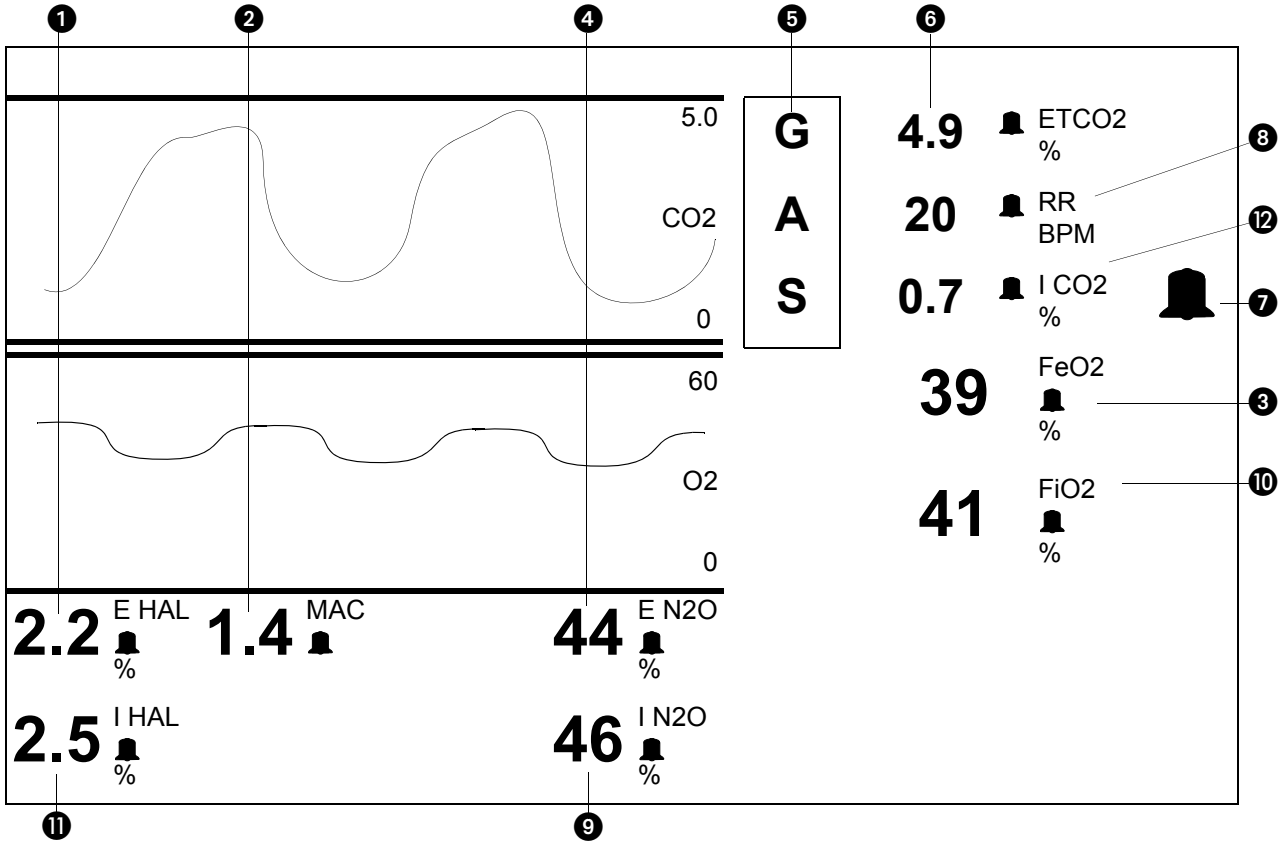



*Figure 24-8: Bedside display (three zones)*

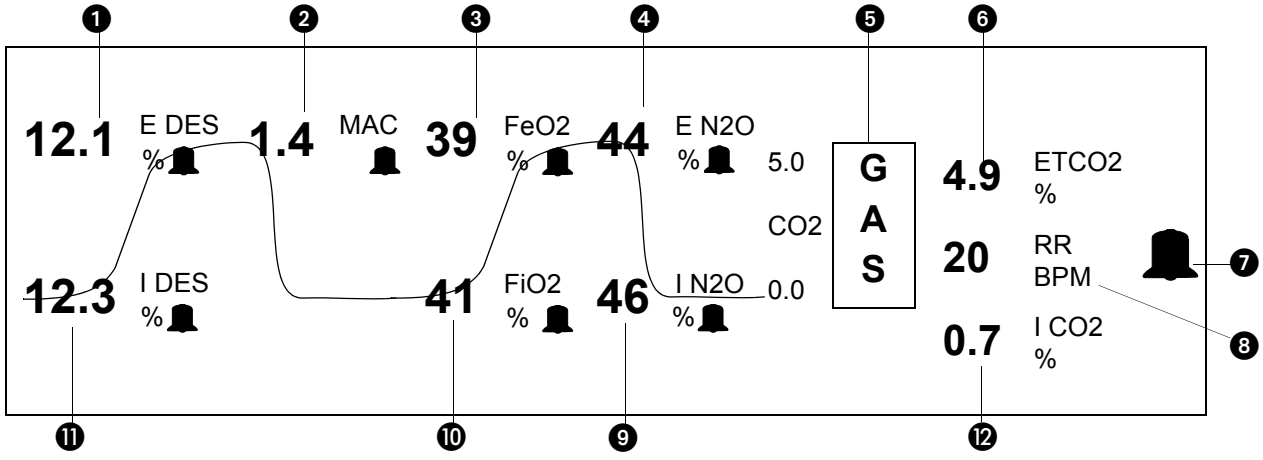



*Figure 24-9: CO2 MODE display*

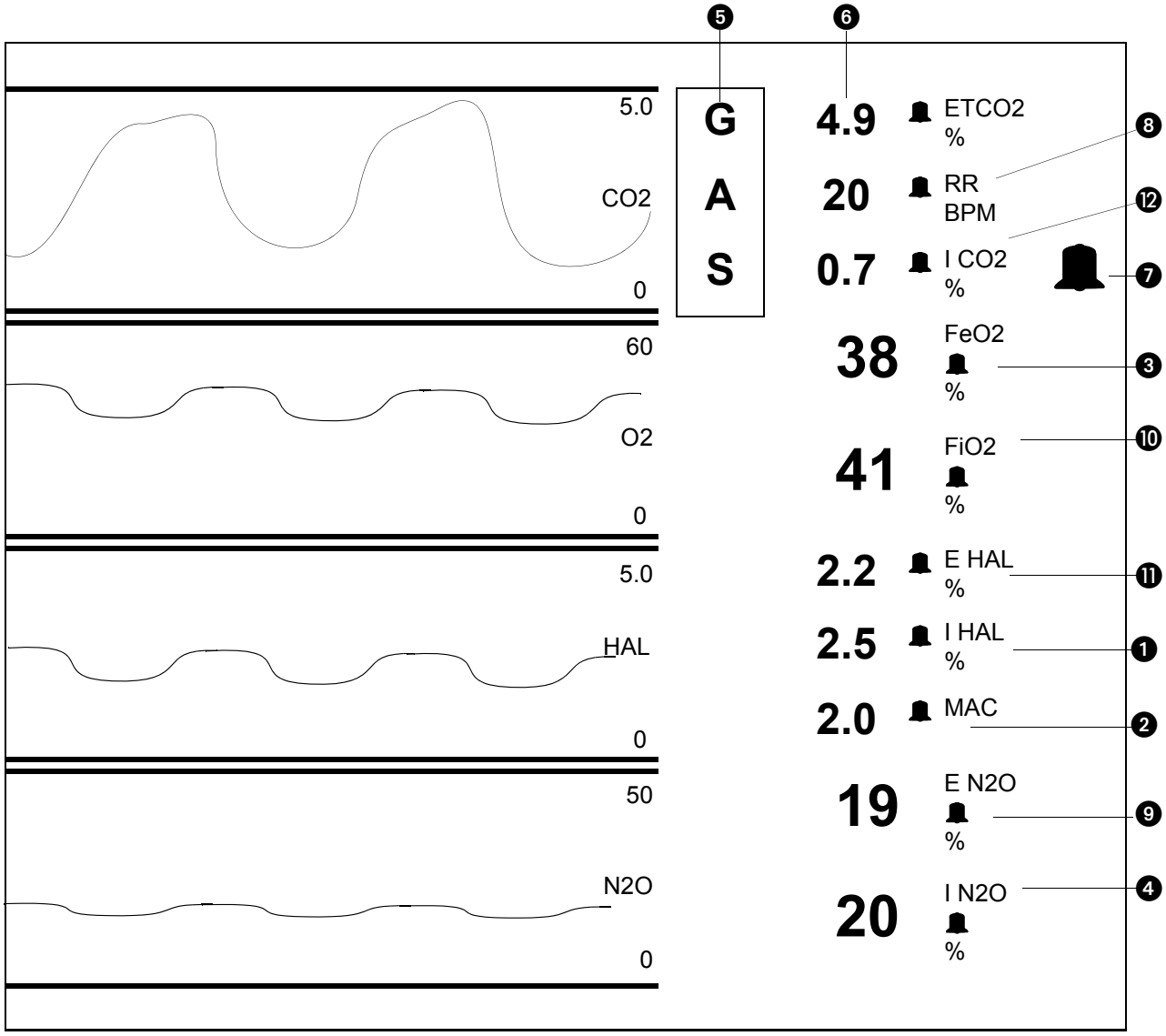



*Figure 24-10: Bedside display (four zones)*

*Figure 24-11* is the only available display option for remote displays.

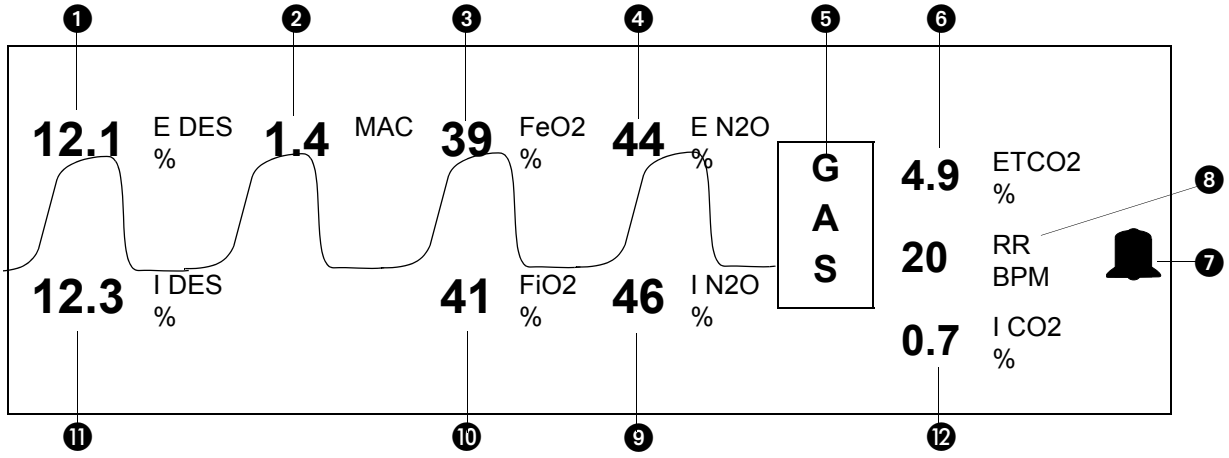



*Figure 24-11: Central monitor or remote display, full width*

The split-view display (refer to *Figure 24-12)* is available only on central monitors.

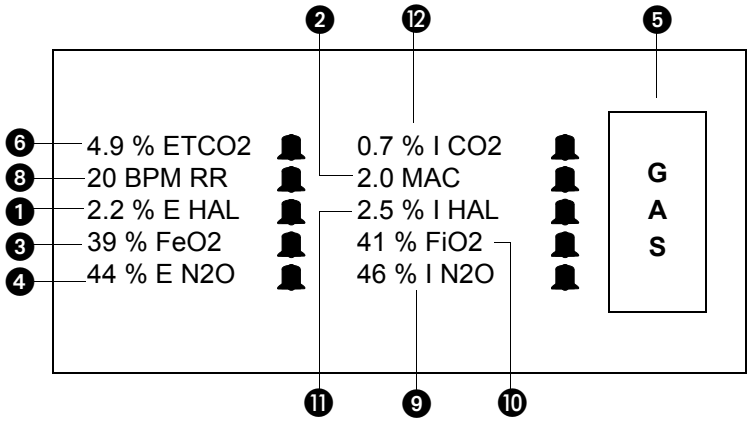



*Figure 24-12: Central monitor display, split-view*

1. Expired agent
2. MAC value (or AMAC, depending on user selection)
3. Fractional expired oxygen
4. Expired nitrous oxide
5. GAS parameter key
6. End-tidal carbon dioxide
7. Alarms status (refer to *Table 1*)
8. Respiratory rate
9. Inspired nitrous oxide
10. Fractional inspired oxygen

⓫ Inspired agent

⓬ Inspired carbon dioxide

*Table 1: Alarm Status*

| Alarm Status | Large Bell |
|---|---|
| At least one alarm ON | Present |
| At least one alarm ON and violated | Flashing |
| All alarms OFF | Replaced with GAS ALM OFF in reverse video |
| At least one alarm ON and alarms temporarily suspended by monitor | Replaced with GAS ALM SUSP in reverse video (flashes if any alarm is violated) |

# Changing the Display Format

You can select to display the expired or inspired values of parameters on the top line of the display. $ETCO_2$ values are always displayed on the top line.

**To display inspired/expired values on the top line:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT
- Select INSP TOP/EXP TOP.

You can turn off the parameter's numeric display by touching the parameter's respective ON/OFF key. Selecting OFF will clear the parameter's numeric values from the display. You cannot turn off the numeric display for $FiO_2$, $ETCO_2$, and respiration rate.

**To turn OFF numeric displays:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch NUMERIC CONTROLS.
- Touch the ON/OFF key for the particular parameter.

## Two Agents

When two anesthetic agents are detected, the anesthetic agent with the higher concentration displays on the top line (numeric display only; refer to *Figure 24-6* on page 24-18), and its position is not user-configurable.

When a second anesthetic agent is no longer present, the display reverts to a single-agent display (refer to *Figure 24-5* on page 24-17).

## Mixed Agents

When a mixture of anesthetic agents is detected, and the analyzer is not able to identify the agents, an *AGENT MIX DETECTED* message displays and an alarm tone sounds.

During this condition, the anesthetic agent labels display as I MIX and E MIX. Inspired, expired, instantaneous numeric values display as questions marks (**???**).

## Unidentified Agents

If no anesthetic agent is identified in the system, the multigas analyzer will display AA for the agent label and **???** for numeric values.

## No Breath Mode

The normal mode of operation is in effect as long as breathing is detected. When no breath has been detected for a duration equal to the APNEA alarm limit setting, the multigas analyzer switches to no breath mode automatically.

When in no breath mode:

1 A NO BREATH DETECTED message displays in the $EtCO_2$ waveform zone.

2 An alarm tone sounds.

3 The ACKNOWLEDGE ALARMS key displays in the $EtCO_2$ waveform zone.

**To stop alarms in no breath mode:**

- Touch ACKNOWLEDGE ALARMS.

If the patient is not connected when gas monitoring is started, then the analyzer will remain in no breath mode.

During no breath mode, measurements of $CO_2$ , $O_2$ , $N_2O$, and the anesthetic agent(s) are continuously performed. Measurements referred to as instantaneous numeric values are displayed at one-second intervals in place of the inspired numeric values. Instantaneous numeric values can change with each display update.

In no breath mode, respiration rate (RR) and the expired values for $CO_2$ , $O_2$ , $N_2O$ and the anesthetic agents are displayed as **???**.

# Enabling and Adjusting Alarms

**The Alarm Limits menu allows you to enable and adjust alarm limits for the following:**

- RR (respiration rate) — high and low limits
- Apnea (delay is measured in seconds) — high limit
- $EtCO_2$ — high and low limits
- I $CO_2$ — high limit
- $FiO_2$ — high and low limits
- $FeO_2$ — high and low limits
- Inspired and Expired $N_2O$ — high and low limits
- Inspired and Expired Anesthetic Agent — high and low limits
- MAC — high and low limits
- AMAC — high and low limits

**To enable and adjust alarm limits:**

- Touch GAS.
- Touch ALARM LIMITS.
- Select a parameter.
- Touch ON for the parameter selected.
- Select the HI = or LO = key.
- Use the arrow keys to set the high and/or low alarm limit or the apnea alarm delay time.
- Touch a parameter key on the right side of the menu to cycle to the next parameter for setting alarm limits.
- Repeat the fourth through seventh steps above until all limits are set.

When the alarm is initially turned ON for $EtCO_2$ and RR, the limit values depend on the patient's current readings for those parameters (these limit values are learned). Alarm limits for all other monitored parameters, when turned ON, always have the same fixed values.

Default values appear for alarm limits when you initially power ON the multigas analyzer, or when patient data is purged during patient admit/discharge. You can modify limits for any of the monitored parameters. These modifications will remain in effect until the unit is turned OFF. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

# Waveform Settings

Waveforms can be displayed for $CO_2$, $O_2$, $N_2O$ and anesthetic agents. Some display formats may be unavailable on some monitors. Refer to *Compatibility* on page 24-9. Turning on multiple waveforms expands the display and increases the number of waveforms in use.

If more zones are selected than are available, the GAS key appears at the bottom of the display, in the numeric key zone. When you touch the GAS numeric key, the GAS parameter is displayed in the lowest-priority display zone.

CO2 MODE displays only the $CO_2$ waveform and the numeric values in a single zone (refer to *Figure 24-9* on page 24-19). When CO2 MODE is ON, the CO2, O2, and N2O keys on the **Waveform Controls** menu are disabled.

The waveforms for $CO_2$, $O_2$, $N_2O$ and anesthetic agents and display only the numeric values can be turned OFF. When all waveforms are OFF, the SCALE, SWEEP SPEED, and FREEZE ON/OFF keys are disabled.

If a parameter's waveform is too large to fit within the screen zone, use the parameter's waveform scale keys to adjust the waveform size.

To freeze the waveform screen, set the FREEZE key to ON. When you freeze the waveform, numeric information continues to be updated. The waveform stays frozen until you touch FREEZE / OFF or touch the NORMAL SCREEN key. The SCALE, SWEEP SPEED, and WAVEFORM CONTROLS keys are disabled when waveforms are frozen.

The sweep speed determines the speed at which the waveform moves across the screen. Available sweep speeds are 25, 12.5, 6.25, 3.12, or 1.56 mm/second.

**To turn CO2 MODE ON or OFF:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch WAVEFORM CONTROLS.
- Touch CO2 MODE ON or OFF.

**To turn the waveform ON or OFF for a particular parameter:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch WAVEFORM CONTROLS.
- Touch ON or OFF for the particular parameter.

***Note:***

*Waveform controls are disabled when CO2 Mode is ON. To turn waveforms ON or OFF, CO2 Mode must be set to OFF.*

**To adjust the waveform scale size:**

- Touch GAS.
- Touch SETUP.
- Touch SCALE.
- Touch the parameter you wish to change.
- Select the desired scale size.

**To freeze all waveform screens:**

- Touch GAS.
- Touch FREEZE / ON.

**To select a sweep speed (for all waveforms):**

- Touch GAS.
- Touch SETUP.
- Touch SWEEP SPEED.
- Select the desired sweep speed.

# MAC and AGEMAC Calculations

You can select mean alveolar concentration (MAC) calculations to be a MAC only calculation, or you can select AGEMAC for MAC calculations based on patient age. When AGEMAC is selected, the patient age is displayed, except on the split-screen display.

If the patient age is not available, the calculation will default to MAC, and the MAC/AGEMAC key will be disabled. The MAC/AGEMAC value will display ??? if the expired values of $N_2O$ and the anesthetic agent are unavailable.

**To select MAC or AGEMAC:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch MAC or AGEMAC.

## MAC Calculations

$$MAC(AA) = \frac{\%EAA}{\times(AA)}$$ (should be calculated for first and second agents)

$$MAC(N2O) = \frac{\%EN2O}{\times(N2O)}$$

$$MAC = MAC(AA) + MAC(N2O)$$

**Where:**

AA = any of five anesthetic agents: HAL, ENF, ISO, SEV, or DES

MAC(AA) = Calculated value of MAC for a given AA

MAC(N2O) = Calculated value of MAC for $N_2O$

EAA = Expired value of AA

EN2O = Expired value of $N_2O$

×(AA) = Agent-specific coefficient, as follows: HAL=0.77, ENF=1.7, ISO=1.15, SEV=2.1, DES=6.0

×(N2O) = 105, the coefficient for $N_2O$

**For example:**

If ENF = 1%, SEV = 1%, and $N_2O$ = 20%

MAC(AA) = 1/1.7 + 1/2.1 = 1.064

MAC(N2O) = 20 / 105 = 0.19

MAC = 1.064 + 0.19 = 1.254 (The result would be rounded to 1.3)

## AGEMAC Calculations

$$AGEMAC(AA) = \frac{MAC(AA)}{[(0.05*TEMP - 0.85) * (1.32 * 10(-0.00303*AGE))]}$$

$$AGEMAC(N_2O) = \frac{EN2O}{[114 * 1.378 * 10(-0.00347*AGE)]}$$

AGEMAC = AGEMAC(AA) + AGEMAC(N2O)

**Where:**

AGEMAC(AA) = AGEMAC value calculated based on AA

AgeMAC(N2O) = AGEMAC value calculated based on $N_2O$

TEMP = Body temperature of the patient. If temperature is not available, then a value of 37° C will be used

AGE = Patient age

AGEMAC = Calculated value of AGEMAC

**For example:**

If ENF = 1%, SEV = 1%, $N_2O$ = 20%, TEMP = 35, and AGE = 50

MAC(AA) = (1/1.7) + (1/2.)1 = 1.064

AGEMAC(AA) = 1.064 / [(0.05*35 - 0.85) * (1.32 * 10(-0.00303*50)) ] = 1.27

AGEMAC(N2O) = 20 / (114 * 1.378 * 10(-0.00347*50)) = 0.19

AGEMAC = 1.27 + 0.19 = 1.46 (The result would be rounded to 1.5)

# Printing the Gas Waveform Zone

You can print multigas values. Refer to *Printing* on page 9-5 for additional information.

**To print the gas waveform zone:**

- Touch GAS.
- Touch PRINT.

# Selecting a Unit of Measurement

$CO_2$ values and alarm limits can be displayed as a percentage (%) or as units of pressure. The units of pressure are either mmHg or kPa, depending on the monitor setup.

To select units of measurement, touch the PERCENT/mmHg (or PERCENT/kPa) key until the desired unit is highlighted.

**To select a measurement unit:**

- Touch GAS.
- Touch SETUP.
- Select PERCENT or mmHg (or kPa, depending on the monitor's setting).

# Suspending and Resuming Sampling

**Sampling can be suspended by touching the SUSPEND SAMPLING key under the following conditions:**

- When suctioning a patient.
- When use (by the patient) is temporarily discontinued.
- When nebulized drugs are being used.

This stops the sampling pump and keeps the system free of debris. When sampling is suspended, the ZERO key on the **Calibration** menu is disabled. The analyzer remains warmed up so that no additional warm-up time is required. Touch the RESUME SAMPLING key to resume sampling.

### Caution:

**Sampling must be resumed for proper monitoring of respiratory gases.**

**To suspend sampling:**

- Touch GAS.
- Touch SUSPEND SAMPLING.
- Touch RESUME SAMPLING to resume sampling.

# Calibrations

***Warning:***

- ***Calibrations must be performed by qualified service engineers.***
- ***The calibration should occur when the multigas analyzer is not actively monitoring a patient.***

## Auto Zero Calibration

To guarantee accurate readings, the zero reference of the multigas analyzer is automatically calibrated on a regular basis. Auto zero calibrations last less than 15 seconds. During auto zero calibrations, the *AUTO ZERO IN PROGRESS* message displays.

The interval between auto zero calibrations depends on the amount of time the multigas analyzer operates. During the first 60 minutes of operation, multiple auto zeros occur. After the unit has been ON for at least 60 minutes and is thermally stable, auto zeros occur at approximately 60-minute intervals.

## Gas Calibration

A gas calibration is recommended when gas values appear to be too low or too high. Always perform a leak test first to verify that the suspected values are not the result of a leak (such as due to a poor connection or a cracked water trap).

The gas calibration procedure is used to recalibrate the gas channels for $CO_2$, $O_2$, $N_2O$, and anesthetic agents. The gas calibration procedure should be performed when the Multigas Analyzer is installed, and thereafter it should be performed once per year. Equipment required for this calibration includes a gas mixture for the calibration, a calibration adapter kit, a gas pressure regulator, and a flow meter. Refer to the *Spacelabs Healthcare Supplies and Accessories Catalog* (P/N 084-1201-xx).

***Warning:***

- ***Performing a gas calibration without the calibrated gas mixture connected adversely affects the accuracy of the multigas analyzer.***
- ***Gas calibrations must be performed by trained personnel only.***

Refer to the *91518 Multigas Analyzer Service Manual* (P/N 070-1328-xx) for details on calibrating the multigas analyzer.

***Note:***

*Waveforms and numeric values may disappear during calibration.*

# Multigas Alarm Delays

*Table 2: Multigas Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Resp Rate High | 15 to 60 bpm | Less than 1 second |
| Resp Rate Low | 4 to 55 bpm | |
| Apnea | | Apnea alarm delay + 1 second |
| $ETCO_2$ High | 1 to 120 mmHg | Less than 1 second |
| $ETCO_2$ Low | 0 to 119 mmHg | |
| $ICO_2$ High | 1 to 40 mmHg | Less than 1 second |
| $FiO_2$ High | 21 to 100% | Less than 1 second |
| $FiO_2$ Low | 29 to 95% | |
| $FeO_2$ High | 16 to 100% | Less than 1 second |
| $FeO_2$ Low | 15 to 95% | |
| $iN_2O$ High | 10 to 80% | Less than 1 second |
| $iN_2O$ Low | 5 to 75% | |
| $eN_2O$ High | 5 to 80% | Less than 1 second |
| $eN_2O$ Low | 0 to 75% | |
| iHAL High | 0.1 to 6% | Less than 1 second |
| iHAL Low | 0 to 5.9% | |
| eHAL High | 0.1 to 6% | Less than 1 second |
| eHAL Low | 0 to 5.9% | |
| iENF High | 0.1 to 6% | Less than 1 second |
| iENF Low | 0 to 5.9% | |
| eENF High | 0.1 to 6% | Less than 1 second |
| eENF Low | 0 to 5.9% | |
| iISO High | 0.1 to 6% | Less than 1 second |
| iISO Low | 0 to 5.9% | |
| eISO High | 0.1 to 6% | Less than 1 second |
| eISO Low | 0 to 5.9% | |

# 91518 Multigas Troubleshooting Guide

The multigas analyzer displays error messages in the gas waveform zone. Many of these messages also trigger an alarm, if configured to do so. If the prompt line is available, the monitor displays messages there as well.

**Caution:**

**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

***Note:***

*The multigas analyzer does not analyze sampled gases while the monitor displays any of these messages.*

Whenever a gas calibration failure occurs, the previous calibration factors are not lost. The multigas analyzer continues to function and report the gas values, but the full accuracy of the values is not guaranteed.

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **Analyzer does not sign on** | ■ Defective hardware.<br>■ Flash memory programming error, or defective software on the interface board. | ■ Contact a qualified field service engineer.<br>■ Contact a qualified field service engineer. |
| **GAS parameter key does not display** | ■ Analyzer is powered OFF. | ■ Power OFF the multigas analyzer, and then power OFF the monitor. Power ON the monitor again, and then power ON the multigas analyzer again.<br>■ Verify that the power ON/OFF button is pressed and illuminated.<br>■ Verify that the multigas analyzer is connected to an AC power outlet. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **GAS parameter key does not display (continued)** | ■ SDLC is not configured correctly. | ■ Verify that the SDLC switch on the back panel of the multigas analyzer is in the correct position.<br>■ Verify that the appropriate SDLC cable and terminator are connected to the monitor (refer to the *91518 Multigas Analyzer Service Manual,* P/N 070-1328-xx).<br>■ If the monitor or the module housing has an SDLC switch, check that the switch is in the correct position. |
| **SENSOR OVER TEMPERATURE-Service Required** | ■ The operating environment temperature is too high. | ■ Use the multigas analyzer only within its intended operating temperature range of 10° to 40° C.<br>■ Contact a qualified field service engineer, and return the unit to Spacelabs Healthcare for repair if the message persists. |
| **OCCLUSION - Check system** | ■ The sampling line is blocked.<br>■ The water trap container if full.<br>■ If the occlusion persists for longer than 40 seconds, the pump will be turned off, and a *RESUME SAMPLING TO RESTART PUMP* message displays below the first message. | ■ Check the sampling line for blockage or crimps, and replace as necessary.<br>■ Empty and clean the water trap container, or replace the container.<br>■ Replace the water trap. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **LEAK DETECTED - Check system**<br><br>**If the leak persists for longer than 40 seconds, the pump powers OFF, and the RESUME SAMPLING key displays** | ■ The water trap is not completely inserted.<br>■ The water trap has an internal leak.<br>■ There is increased gas pressure in the system beyond typical ventilation, such as from manual ventilation. | ■ Insert the water trap and ensure that it is fully seated.<br>■ Replace the water trap.<br>■ Eliminate the source of the increased pressure, and press the RESUME SAMPLING key, if displayed, to clear the message. |
| **SERVICE REQUIRED - Send for repair** | ■ Defective hardware.<br>■ Module self-test failure.<br>■ Invalid or corrupt EEPROM configurations.<br>■ A software problem was detected. | ■ Contact a qualified field service personnel, and return the unit to Spacelabs Healthcare for repair. |
| **COMMUNICATION LINK LOST - Service required -OR- COMMUNICATION DROP OUTS - Service required** | ■ An internal communication problem was detected. | ■ Contact qualified field service personnel and return the unit to Spacelabs Healthcare for repair. |
| **SERVICE CAL MODE - Patient is not monitored** | ■ The **SERVICE CAL** menu is displayed on the bedside monitor. | ■ Touch NORMAL SCREEN to exit this mode on the bedside monitor. |
| **SAMPLING SUSPENDED - Patient is not monitored** | ■ Sampling was suspended by the user by pressing the SUSPEND SAMPLING or END CASE key. | ■ Touch RESUME SAMPLING or START CASE to exit this mode on the bedside monitor. |
| **NO BREATH DETECTED** | ■ Breaths are not detected for a duration equal to the APNEA timeout duration. | ■ Verify sensor is properly connected to the patient. Message will clear after a valid respiratory rate is detected, or the ACKNOWLEDGE ALARMS key is touched. |

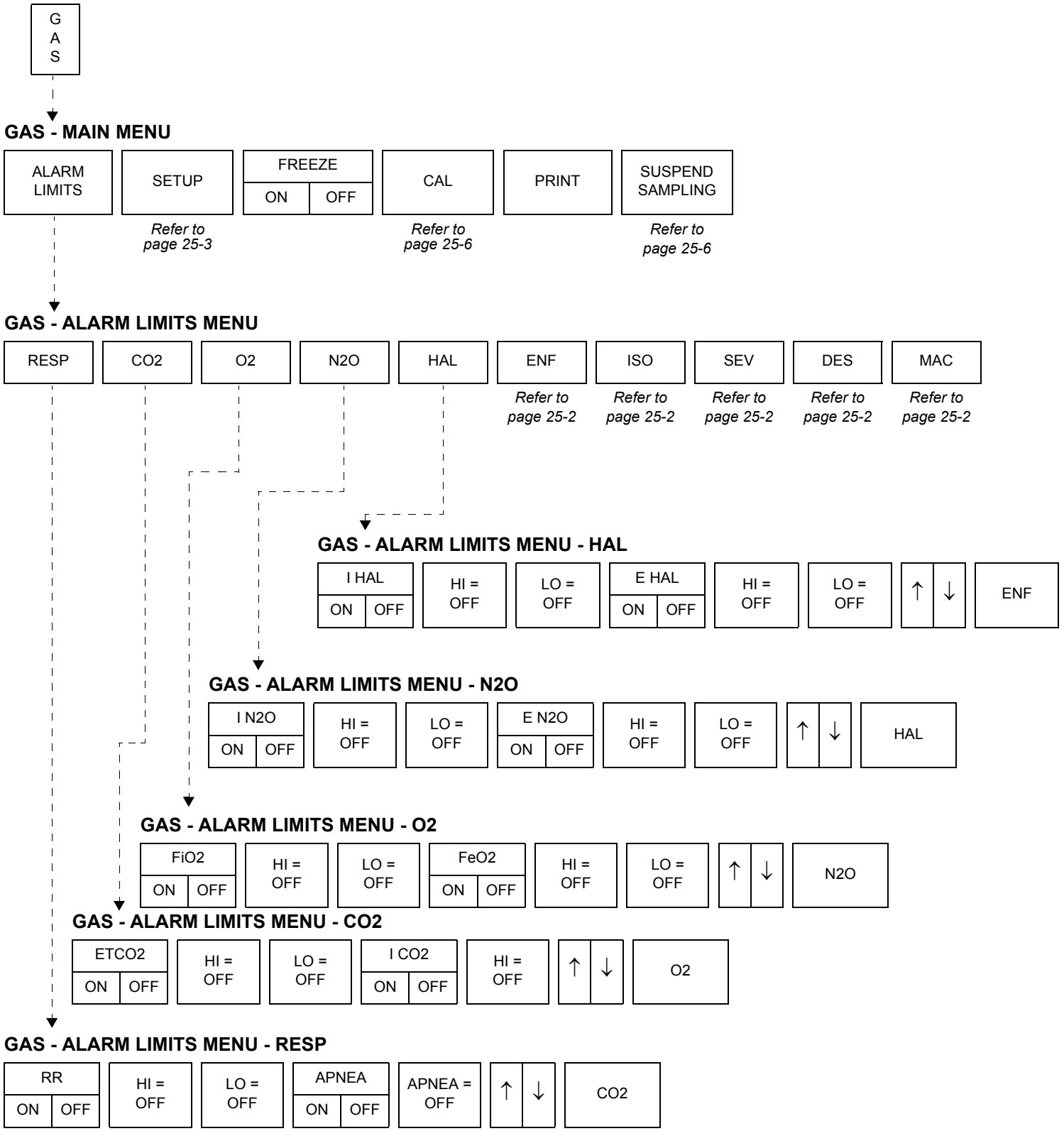
| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **Inspired values fluctuate over a wider and more extreme range than what is expected.** | ■ Analyzer is in no breath mode. | ■ Verify sensor is properly connected to the patient. Message will clear after a valid respiratory rate is detected, or the ACKNOWLEDGE ALARMS key is touched.<br>■ To exit this mode, if the ACKNOWLEDGE ALARMS key is not present:<br>1 Touch the GAS key.<br>2 Touch SUSPEND SAMPLING, then touch YES.<br>3 Touch RESUME SAMPLING, then touch YES. |
| **ZERO IN PROGRESS** | ■ A ZERO calibration is in progress. | ■ Wait until the ZERO calibration is successfully completed. The message disappears. |
| **AUTO ZERO IN PROGRESS** | ■ An automatic zero calibration is in progress. | ■ Wait for the message to disappear. |
| **CAL GAS IN PROGRESS** | ■ CAL GAS calibration is in progress. | ■ Wait until the CAL GAS calibration is successfully completed. The message disappears. |
| **CAL GAS INCOMPLETE - Sampling system not ready** | ■ CAL GAS calibration was not completed successfully. | ■ Repeat the calibration. Contact your biomed or a qualified field service personnel if the CAL GAS fails again. |
| **CAL GAS FAILED - Check gas supply** | ■ The unit could not calibrate the gas channel. | ■ Repeat the calibration. Contact your biomed or qualified field service personnel if the CAL GAS fails again. |
| **SENSOR WARMING UP** | ■ The unit is warming up. | ■ Wait until warm up completes before operating. |
| **AGENT WARMING UP** | ■ The anesthetic agent unit is warming up. | ■ Wait until warm up completes before measuring the anesthetic gases. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **CHECK OR REPLACE WATER TRAP** | ■ There is no water trap installed in the holder.<br>■ The water trap container is full. | ■ Install a water trap.<br>■ Empty and clean the water trap container, or replace the container.<br>■ Replace the water trap. |
| **AMBIENT PRESSURE OUT OF NORMAL OPERATION RANGE** | ■ The atmospheric (ambient) pressure exceeds the multigas analyzer environmental operating requirements. | ■ Check the multigas analyzer environmental operating requirements in the *91518 Multigas Analyzer* data sheet (P/N 061-1775-xx). |
| **High values observed** | ■ A CAL GAS calibration was performed while there was a leak in the sample circuit. | ■ Check connections and check for a broken water trap. Perform leak test. Verify the anesthesia delivery devices and vaporizer calibrations. Refer to the *91518 Multigas Analyzer Service Manual* (P/N 070-1328-xx) for details.<br>■ Verify vaporizer accuracy. |
| **Low values observed** | ■ A leak exists at the sampling line connection, a water trap is broken at the luer connection, or there is a leak in the water trap. | ■ Check connections and check for a broken water trap. Perform leak test. Refer to the *91518 Multigas Analyzer Service Manual* (P/N 070-1328-xx) for details.<br>■ Verify the anesthesia delivery device and vaporizer calibrations.<br>■ Verify vaporizer accuracy. |

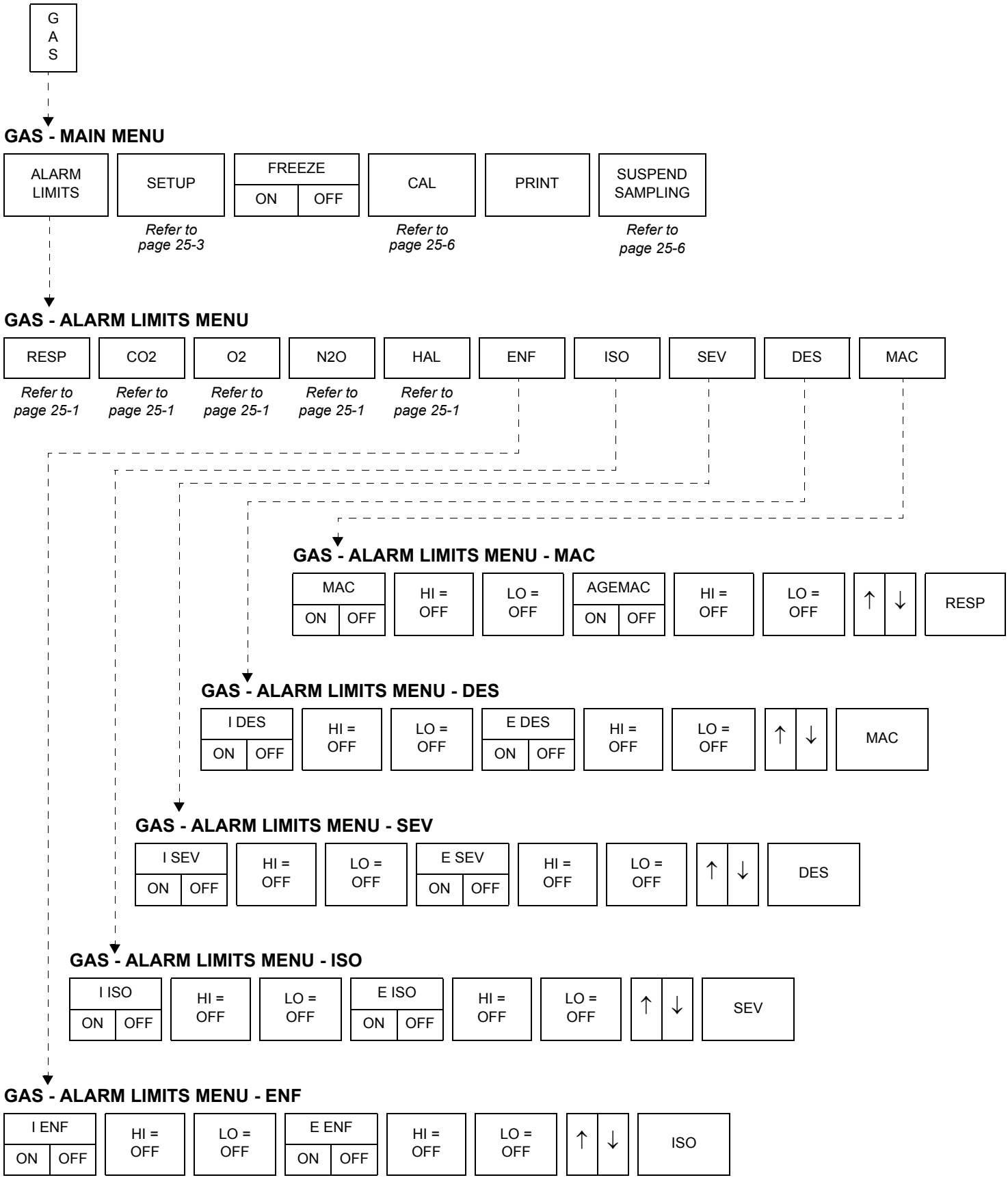
| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **AGENT MIX DETECTED** | ■ A mixture of anesthetic agents is detected, and the analyzer is not able to identify the agents. | ■ The multigas analyzer is not designed to simultaneously identify and measure more than two anesthetic agents. Inaccurate numeric concentration values may be displayed when agents are mixed. Depending on the agents used, the residue in the breathing or delivery system, and the concentration left in the patient's lungs, a mixed agent condition can last for more than an hour.<br>■ If the message persists, contact your biomed or qualified field service personnel. |

# Multigas (92518)

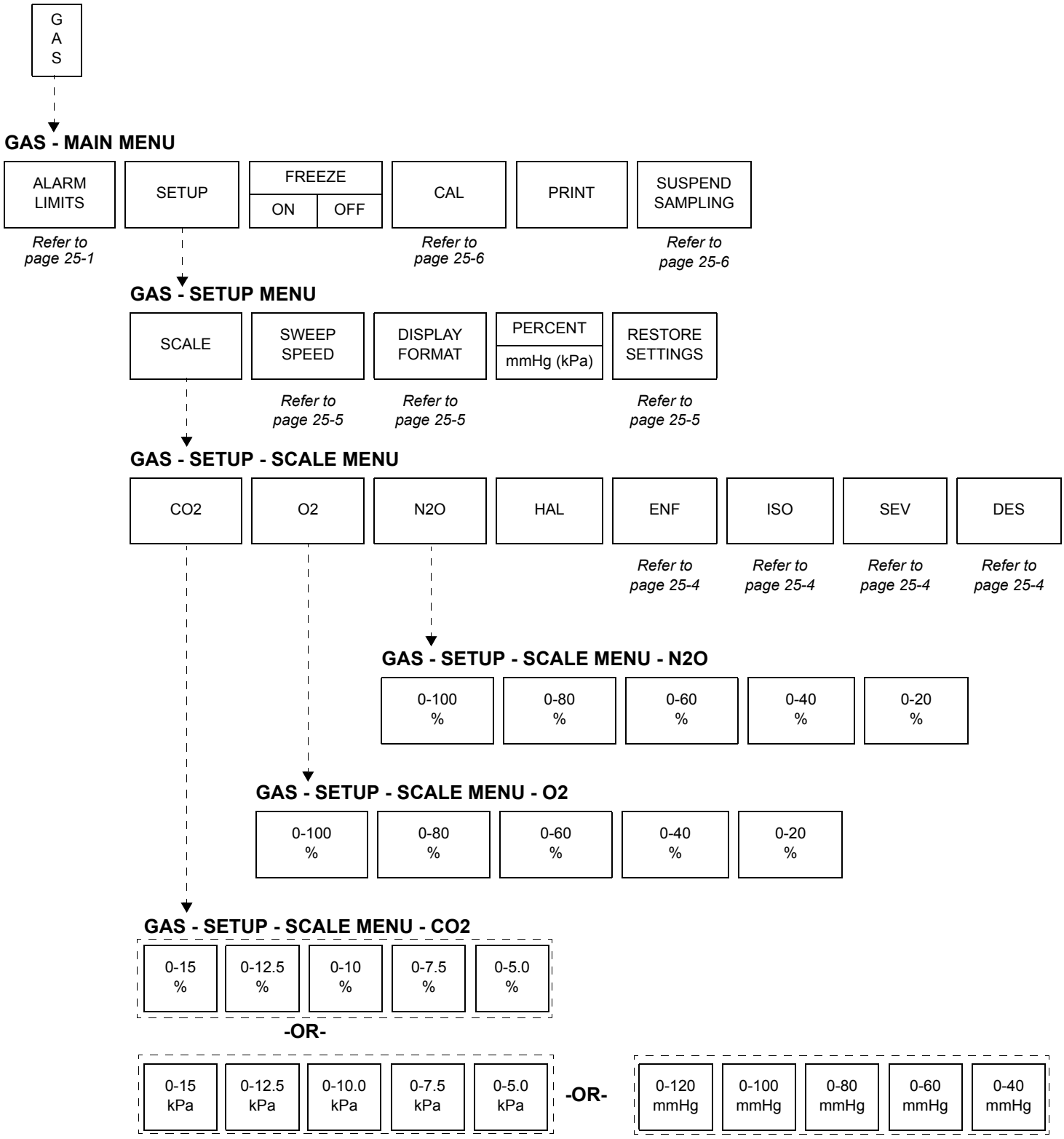
## Directory of Keys



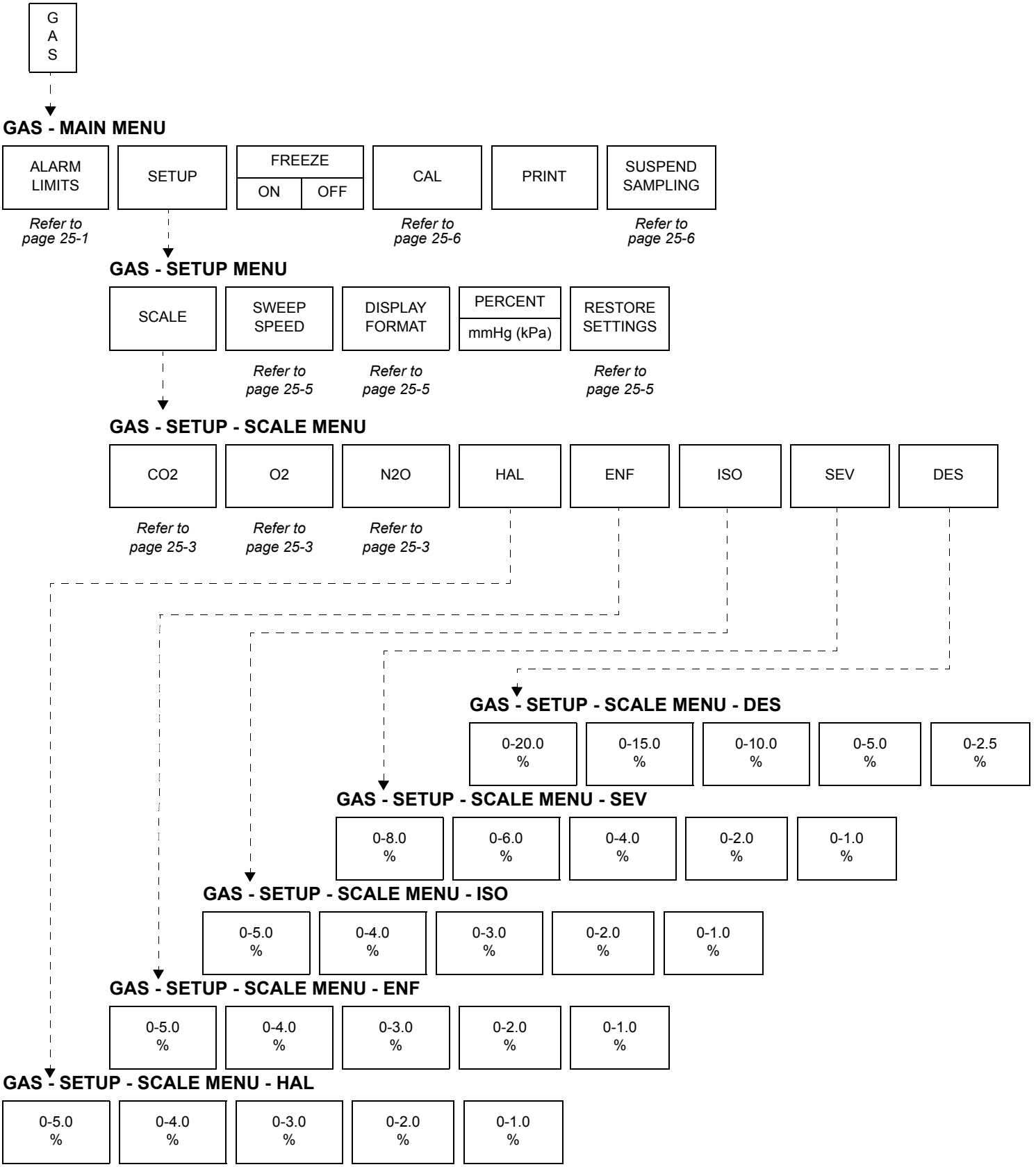
## Alarm Limits (continued)



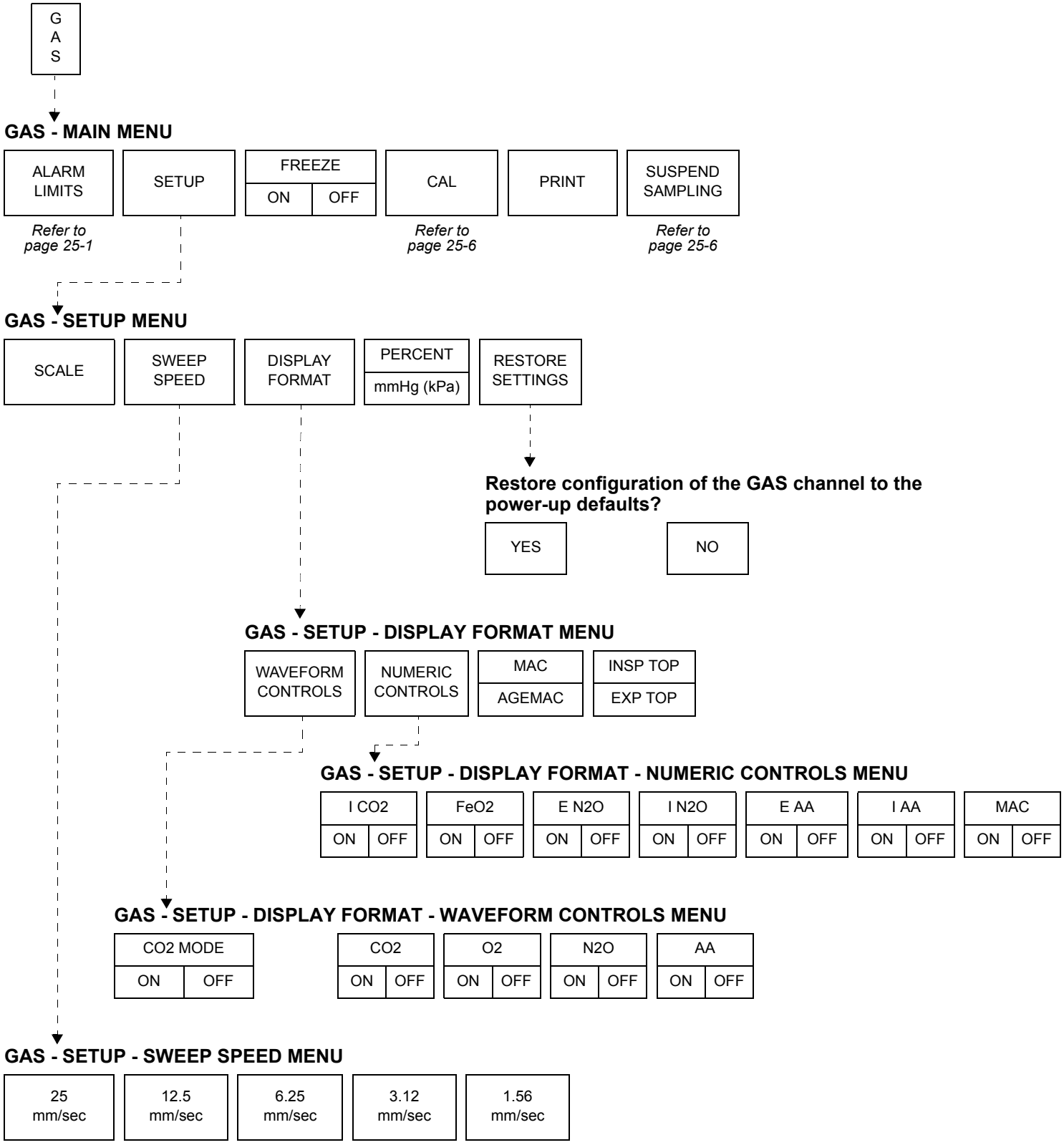
# SETUP - SCALE MENU



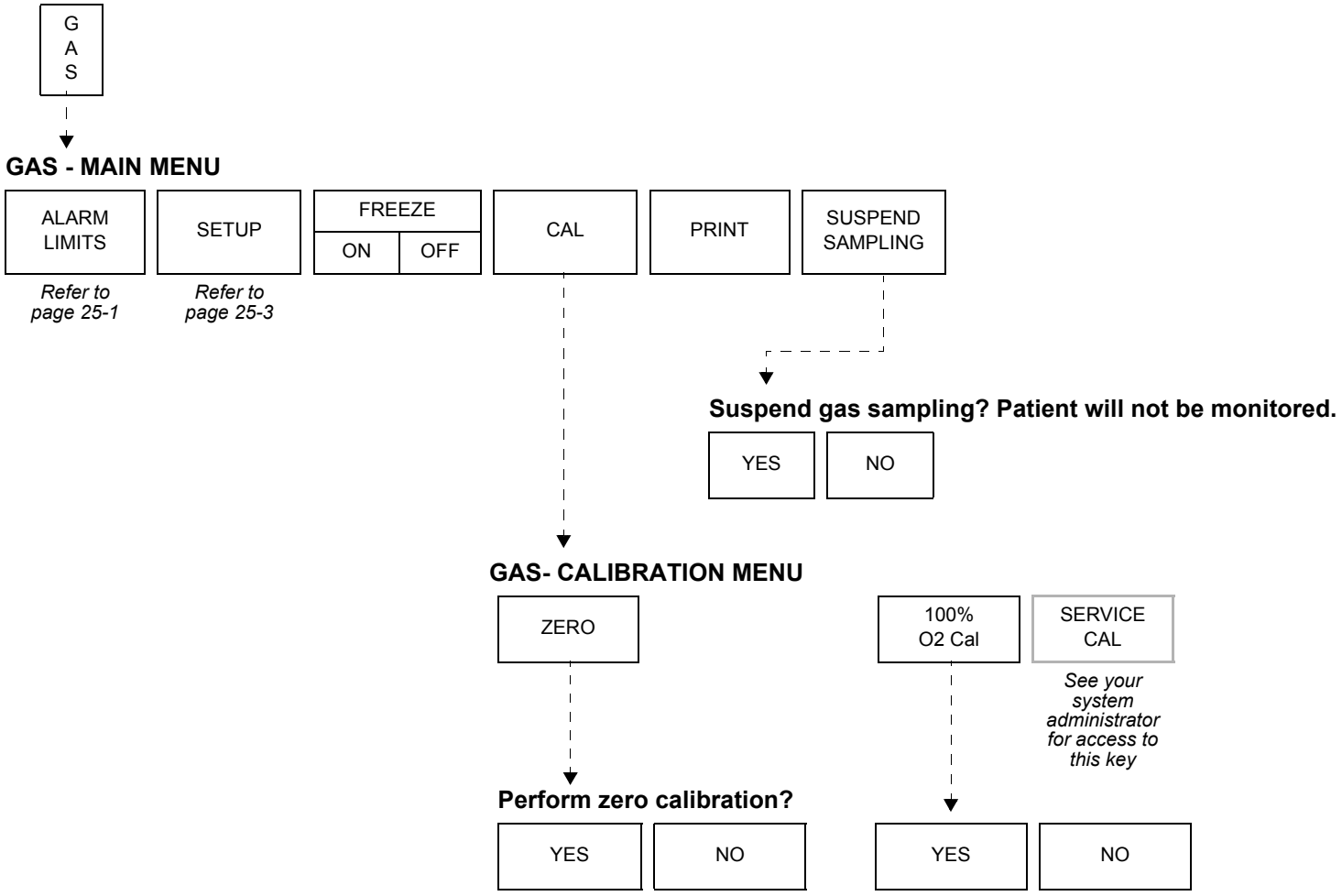
# SETUP - SCALE MENU (continued)



## SETUP (continued)



# GAS - MAIN MENU (continued)



# Multigas (92518)

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## Overview

The Spacelabs Healthcare Multigas Module is a sidestream analyzer that simultaneously monitors gas concentrations and alerts clinical personnel when the concentration of anesthetic agents, oxygen ($O_2$), carbon dioxide ($CO_2$), or nitrous oxide ($N_2O$) moves outside the defined limits. The anesthetic agent being administered is automatically identified.

## Indications for Use

The Spacelabs Healthcare 92518 Multigas Module provides a means to monitor a variety of gas concentrations and alert clinical personnel when the concentration of anesthetic agent(s), oxygen, carbon dioxide, or nitrous oxide moves outside of user-defined limits. The multigas module is capable of automatically identifying which anesthetic agent(s) is being administered.

The 92518 Multigas Module is intended to be used with and controlled by a Spacelabs Healthcare Ultraview-family monitor. The 92518 Multigas Module is intended to be used for monitoring all hospitalized patients, under the direction of qualified medical personnel.

Although the 92518 Multigas Module alarms when the duration between breaths exceeds user defined limits, it is not intended to be a primary diagnostic apnea monitor and/or recording device.

**Caution:**

**The 92518 Multigas Module is not intended to be used as the only means of monitoring a patient. It is intended as an adjunct in patient assessment and must be used in conjunction with other assessments of clinical signs and symptoms.**

***Note:***

Refer to *Compatibility on page 25-10* for more information.

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to the 92518 Multigas Module. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to several physiological parameters or to the monitoring system itself.

## Warnings

The life or health of a patient, clinical staff members, or other persons may be endangered if the warnings in this section are not followed.

***Warning:***

- ***No modification of this equipment is allowed without authorization of the manufacturer. If this equipment is modified, appropriate inspection and testing must be conducted to ensure continued safe operation.***
- ***Always verify that all sample line adapter connections are tight, and verify proper operation before attaching the sample line to a patient.***
- ***Connect the multigas module's sample gas outlet to the hospital scavenging system to prevent pollution of the room air.***
- ***To avoid explosion hazards, flammable anesthetic agents, such as ether and cyclopropane, must not be used in the multigas module.***
- ***Only halothane (HAL), enflurane (ENF), isoflurane (ISO), sevoflurane (SEV), and desflurane (DES) are suitable for use. If any other halogenated anesthetic agent is present, it will be misidentified and/or will interfere with the reported anesthetic agent concentrations.***
- ***The use of antistatic or electrically conductive breathing tubes when using high-frequency electrosurgery equipment may increase the risk of burns and is, therefore, not recommended in any application of the multigas module.***
- ***The multigas module is not intended for use in an MRI environment.***
- ***Operation outside the specified values may cause inaccurate results.***
- ***Carefully route patient cabling (the sample line) to reduce the possibility of patient entanglement or strangulation.***
- ***To ensure patient electrical isolation, connect only to other equipment with circuits that are electrically isolated.***

- ***Do not use adult/pediatric type sample line configurations with infants; this may add dead space to the patient circuit.***
- ***Do not use infant type sample line configurations with adults; this may result in excessive flow resistance.***
- ***Do not reuse disposable sample lines.***

## Cautions

Equipment may be damaged or cease to function properly if the cautions in this section are not followed.

**Caution:**

- **When administering anesthetic agents, incorrect agent identification may occur when a mixture of more than two anesthetic agents occurs in the sample circuit.**
- **Always verify your vaporizer setting when administering anesthetic agents.**
- **Use only Spacelabs Healthcare sample lines and accessories. Other sample lines may cause inaccurate readings and malfunctions. The multigas module must use a sample line that is fabricated from a special material. Use of other sample lines may result in erroneous readings.**
- **Follow local hospital protocols to dispose of used and contaminated single-use accessories.**
- **The diameter of the scavenging system line must be two to three times larger than the sample line tubing to avoid changes in the operating pressure of the multigas module and consequential inaccurate readings or internal damage.**
- **Route the scavenger hose so that it does not kink during operation of the monitor. A kinked or partially kinked scavenger hose will impair performance of the multigas module.**
- **If the patient's airway is configured with a closed suctioning system, the airway adapter must be placed near the suctioning system (on the ventilator side). This helps to ensure that the sampling adapter is not impaired during and after suctioning.**
- **Check the Nomoline adapter regularly during monitoring.**
- **Do not operate the 92518 Multigas Module outside the specified operating temperature environment.**
- **Since a successful zeroing requires the presence of ambient air (21% $O_2$ and 0% $CO_2$) in the gas analyzer, ensure that the module is placed in a well-ventilated location.**
- **Avoid breathing near the analyzer before or during the zeroing procedure.**
- **The Nomoline sample line and its interfaces are non-sterile devices. To avoid damage, do not autoclave any part of the sample line.**
- **Use only adapter cables supplied by Spacelabs Healthcare.**
- **Do not use the 92518 Multigas Module with metered-dose inhalers or nebulized medications; this may clog the bacteria filter in the sample line connector.**
- **Check that the gas sample flow is not too high for the present patient category.**

- **Measurements can be affected by mobile and RF communications equipment. Make sure that the 92518 Multigas Module is used in the non-electromagnetic environment specified in this manual.**
- **The 92518 Multigas Module is intended for use by authorized and trained medical personnel only.**
- **To ensure that parameter measurements (readings) are accurate, take readings only when the multigas module is in a stable condition.**
- **Do not get this module wet; it may stop functioning. If your module does get wet, contact a Spacelabs Healthcare field service representative.**

***Note:***

- *Do not apply negative pressure to the Nomoline sample line (for example, with a syringe) to remove condensed water. Too strong a positive or negative pressure in the patient circuit may affect the sample flow.*
- *Strong scavenging suction pressure may affect the sample flow.*
- *The sample lines are for single-patient use only. Cleaning deteriorates the properties of the sample line, resulting in slower response time and more frequent occlusions. Between patients, replace the sample lines.*
- *Before you administer nebulized drugs to a patient connected to the multigas module, disconnect the sample line from the patient or stop the pump by touching the SUSPEND SAMPLING key.*
- *To facilitate disconnecting and reconnecting the sample line, use a T-connector in the patient airway circuit and keep sampling suspended until all nebulized drugs have cleared from the patient's airway.*

# 92518 Multigas Setup

Refer to the *Multigas Module 92518 Service Manual* (P/N 070-2362-xx) for instructions on connecting the module to a Spacelabs Healthcare monitor.

## Compatibility

The 92518 Multigas Module is compatible with the following Spacelabs Healthcare monitors:

- Ultraview SL™ SL2400 (91369), SL2600 (91370), SL2700 (91387-27), SL2800 (91387-28)
- Ultraview® UCW® (90385)*
- Ultraview 1700 (90387)*
- Ultraview 1500 (90363)
- Ultraview 1600 (90364)
- Ultraview 1050 (90369)
- Ultraview 1030 (90367)
- XPREZZON™ Stationary Monitor (91393)

**The 92518 Multigas Module does not support any UCW or Ultraview monitors with S/N below 387-1xxxxx.*

The following monitors are not supported: Ultracare SLP100, PC1 (90303), PC2 (90305), PCX (90308), and PC Scout® (90309).

If more zones are selected than are available, the GAS key appears at the bottom of the display, in the numeric key zone. When you touch the GAS numeric key, the GAS parameter is displayed in the lowest-priority display zone.

When monitoring gas concentrations on a monitor limited to three or four waveforms, the GAS parameter should be set to display only one or two zones.

***Note:***

- *If a 92518 Multigas Module is connected to a monitor that is not supported, the module will sign on with the following message:* This monitor does not support GAS.
- *If a remote view is attempted of a bedside monitor hosting a 92518 Multigas Module that displays this message, the remote shall display the same message as well.*

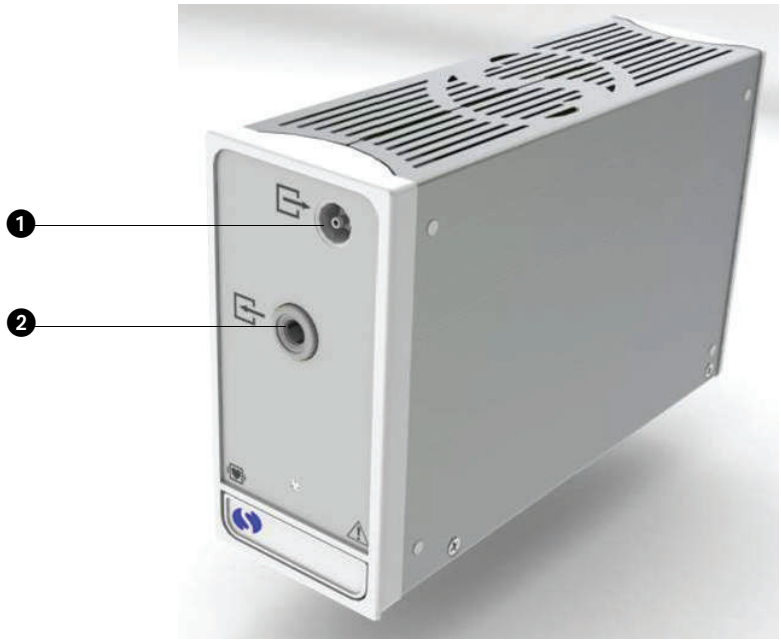



*Figure 25-1: Multigas module front panel controls and features*

1. Gas scavenging port
2. Inlet sample port (LEGI — Light Emitting Gas Inlet)

### Light Emitting Gas Inlet (LEGI)

Common to all 92518 multigas modules is the light emitting gas inlet (LEGI), which detects the presence of a Nomoline sample line and presents color-coded status information (refer to *Table 1* on page 25-12).

As long as no sample line is connected, a multigas module stays in a low-power, sleep mode. Once the sample line is connected, the multigas module switches to measuring mode and starts delivering gas data.

*Table 1: Status Indicated by the LEGI*

| Indication | Status |
|---|---|
| Steady green light | System OK |
| Blinking green light | Zeroing in progress |
| Steady blue light | Anesthetic agent present |
| Steady red light | Sensor error |
| Blinking red light | Check sample line |

# Patient Connection

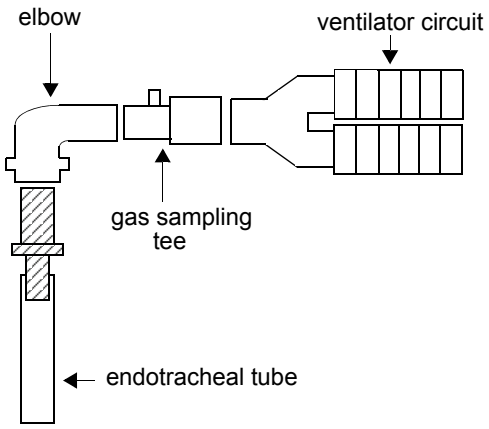



*Figure 25-2: Example of sidestream multigas setup for an adult*

## Pre-Use Check

Before connecting the Nomoline sample line to the breathing circuit, do the following:

***Warning:***

***Always verify the sample line adapter's tight connection and proper operation of the multigas module before attaching to a patient.***

1 Connect the sample line to the module gas inlet connector (LEGI).

2 Check that the LEGI shows a steady green light indicating that the system is OK.

3 Check that the $O_2$ reading on the monitor is correct (21%).

4 Breathe into the sample line and check that valid $CO_2$ waveforms and values are displayed on the monitor.

5 Prior to connecting to the patient airway, verify that there are no leaks in the sample line by sealing the end of the sample line with your thumb.

6 After approximately 15 seconds, the SAMPLE LINE OCCLUDED message should display on the monitor.

7 If this does not occur within 30 seconds, check for an air leak by removing the sample line. Repeat the test.

8 The Nomoline sample line must be connected to the Inlet port of the 92518 Multigas Module.

9 The gas exhaust port is then connected to the scavenging system.

## Maintenance

Gas readings should be verified by conducting the recommended maintenance checks (refer to *Multigas Module 92518 Service Manual*, P/N 070-2362-xx, for more information).

## Sample Line

The 92518 Multigas Module uses the specially designed Nomoline Sample line.

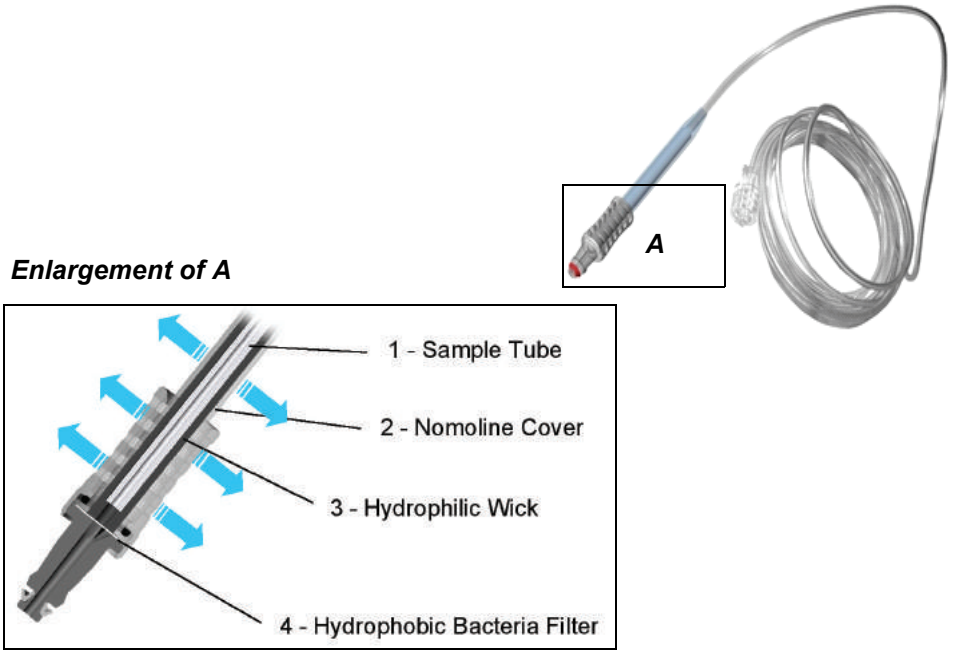



*Figure 25-3: Nomoline Sample line with enlarged view of connector*

***Note:***

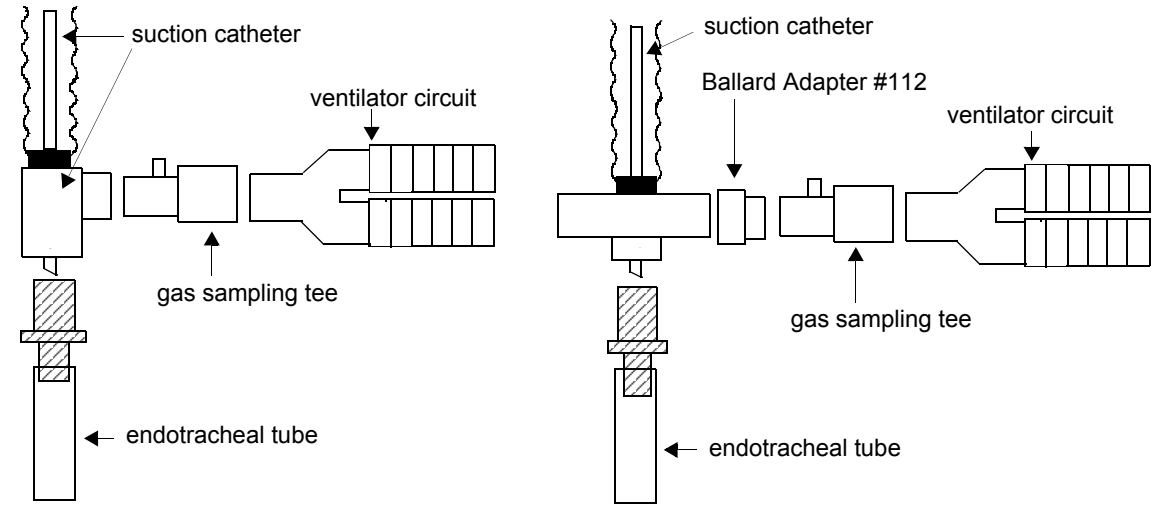
- *The sample line is for single-patient use only.*
- *The disposable Nomoline sample line should be replaced when the SAMPLE LINE OCCLUDED message displays.*
- *Remove and check the sample line when NO SAMPLING LINE message persists.*

## Closed-Circuit Tracheal Suction Systems

Closed-circuit tracheal suction systems (such as those provided by Ballard) allow the endotracheal tube to be periodically suctioned without detaching it from the ventilator circuit. Spacelabs Healthcare recommends the use of Ballard Model 221 elbow closed-circuit tracheal suction systems, or similar systems, with its capnography modules and multigas modules. Such a system enables the gas sampling tee to be placed outside the tube through which fluids are being suctioned, reducing the chance of occluding the airway.

Spacelabs Healthcare does not recommend using traditional setups that require the airway adapter to be inline with the endotracheal tube. However, if you prefer a traditional setup, such as the Ballard Model 2205 style, use the Ballard Model 112 adapter to move the airway adapter away from the suction catheter.

*Figure 25-4* shows examples of setups using the Ballard Model 221 and Model 2205 styles (with Model 112 adapter). Similar closed systems, such as the Concord Portex (not shown), must be placed in the ventilator circuit in the same positions as shown in *Figure 25-4*.




**Ballard elbow closed tracheal suction system (Model 221)** **-OR-** **Ballard closed tracheal suction system with adapter (Model 2205/Adapter #112)**

*Figure 25-4: Ballard setups*

# Operation

$CO_2$, $N_2O$, and anesthetic agents are measured by drawing a sample gas stream into the measuring chamber. The multigas module uses nondispersive infrared radiation to measure the absorption of the gas sample at seven infrared wavelengths, which are selected using optical narrow band filters. The infrared radiation detectors are thermopiles.

Concentrations of $CO_2$ and $N_2O$ are calculated from absorption measured at 3 to 5 µm. Identification of anesthetic agents and calculation of their concentrations is performed by measuring absorptions at five wavelengths from 8 to 9 µm, and by solving a set of five equations. Measurement accuracy is achieved through software compensation.

***Warning:***

***Only halothane (HAL), enflurane (ENF), isoflurane (ISO), sevoflurane (SEV), and desflurane (DES) are suitable for use with the multigas module. If any other halogenated anesthetic agent is present, it will be misidentified and/or will interfere with the reported anesthetic agent concentrations.***

**Caution:**

- **Caregivers should account for the 50 ±10 ml/min sampling rate when working with low volume capacity patients.**
- **When administering anesthetic agents, incorrect agent identification may occur when a mixture of more than two anesthetic agents occurs in the sample circuit.**

$O_2$ concentration is measured with a paramagnetic oxygen sensor. The sensor uses a differential pressure transducer to compare the pressure gradient produced when reference and sample input gases are exposed to an oscillating magnetic field.

Because this method of measurement has a fast response time, inspired and expired values of $O_2$ can be reported. A sidestream sampling technique is used to acquire respiratory gases from an endotracheal or tracheostomy tube or anesthesia mask. A constant-flow vacuum system maintains the flow rate through the sample line.

The multigas module automatically compensates for the ambient barometric pressure to ensure accurate readings. Both $CO_2$ values may appear in partial pressure (in mmHg or kPa) or in percent (%).

$$\% \text{ Gas} = \frac{\text{PARTIAL PRESSURE GAS}}{\text{BAROMETRIC PRESSURE}} \times 100\%$$

***Note:***

*Respiration rate and alarm limit accuracies are not specified above 95 breaths per minute.*

## Powering Up the Unit

It is not possible to power ON the 92518 Multigas Module directly. The 92518 Multigas Module only powers up through the module's connection to the host monitor.

***Note:***

*The multigas module is protected against the effects of a cardiac defibrillation discharge, and it is safe to use on patients with a cardiac pacemaker or other electrical stimulation.*

### Initialization

The message GAS SENSOR WARMING UP may display when the module is first powered up. This message can last up to one minute before the bench is warmed up enough. The monitor may also display one or more zeroes progress messages because of an automatic zeroing process.

During power-up, the normal screen may display on the monitor before the GAS SENSOR WARMING UP message displays.

***Note:***

- *Typical rise time of $CO_2$ is < 200 ms.*
- *Typical rise time of $O_2$ is < 450 ms.*
- *Typical rise time of $N_2O$ is < 350 ms.*
- *Anesthetic Agents identification time is <20 seconds.*
- *Operation to full specification in <20 seconds.*

**Caution:**

- **The multigas module requires approximately 20 seconds to warm up for concentration reporting, automatic agent identification, and full accuracy specification. You may use the multigas module prior to full warm-up, but be aware of possible inaccuracies in gas analysis.**
- **When the module is powered up through the host monitor, all default settings for gas monitoring will be re-established. Any modifications made to the default settings (alarm limits, text display, etc.) prior to interruption of power will be lost.**

**To start multigas monitoring with the power-up monitor (host device):**

- Plug the module into the monitor.
- Connect the sample line to the inlet sample port.
- Touch GAS.
- Prepare the patient according to hospital procedures.
- Allow the multigas module to warm up for a minimum of 20 seconds for $CO_2$, $O_2$, and $N_2O$ detection, automatic agent identification, and full accuracy specification.
- Connect the other end of the gas sample line to the gas sampling tee or breathing circuit.
- During the use of anesthetic agents, ensure that the hospital scavenging line is connected to the scavenger port on the multigas module.

# Patient Monitoring

Some Spacelabs Healthcare monitors support START CASE/END CASE functions. When available, touch START CASE on the monitor to begin patient monitoring.

When using the multigas module with monitors that do not support START CASE/END CASE, power up the module by connecting it to a monitor, then wait for initialization to complete. Patient monitoring begins when initialization is complete.

When a case has been ended by touching END CASE on the monitor, all alarms are deactivated, the multigas module's sampling pump is turned OFF, and the multigas module automatically enters suspended sampling mode.

The multigas module remains warmed up so that no additional warm-up time is required when you resume patient monitoring. Touch the START CASE or RESUME SAMPLING key to resume monitoring (refer to *Suspending and Resuming Sampling* on page 25-33).

# Display Detail

When you first connect the multigas module to a monitor, the GAS parameter key displays to the right of a flat waveform.

Some display formats may be unavailable on some Spacelabs Healthcare monitors. Refer to *Compatibility* on page 25-10.

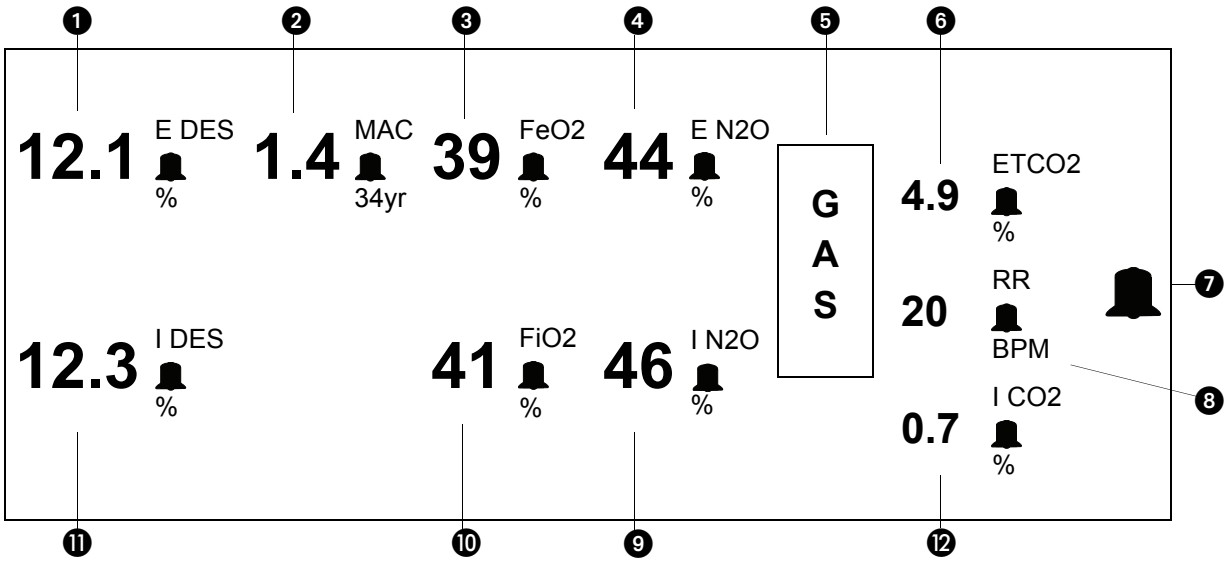



*Figure 25-5: Bedside display*

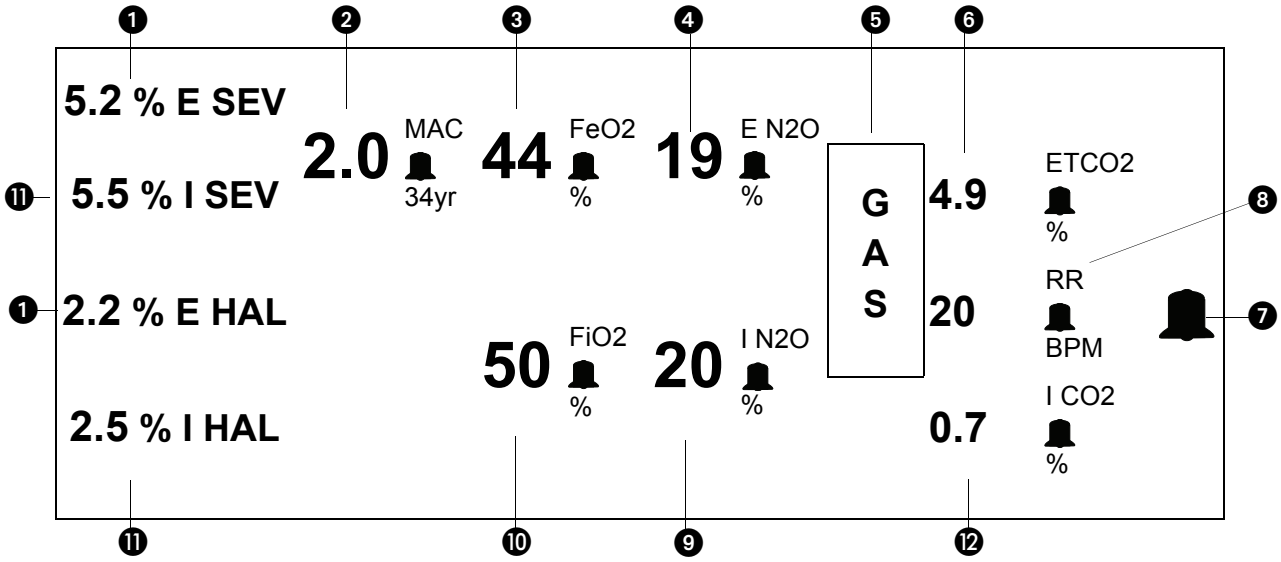



*Figure 25-6: Bedside display, two anesthetic agents*

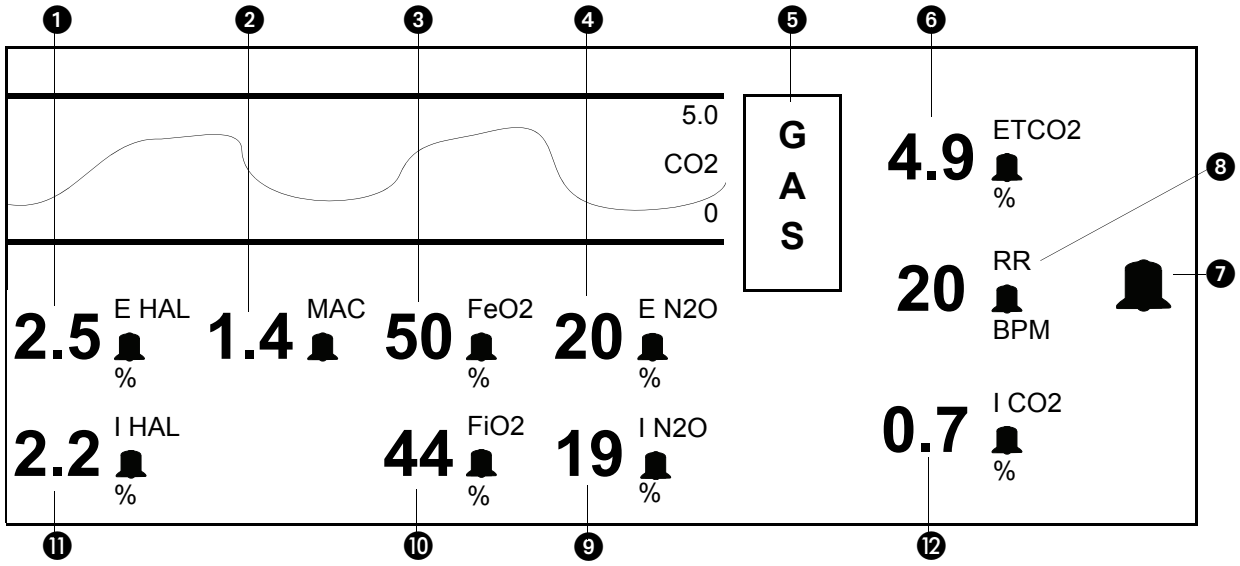



*Figure 25-7: Bedside display (one zone), CO2 waveform ON*

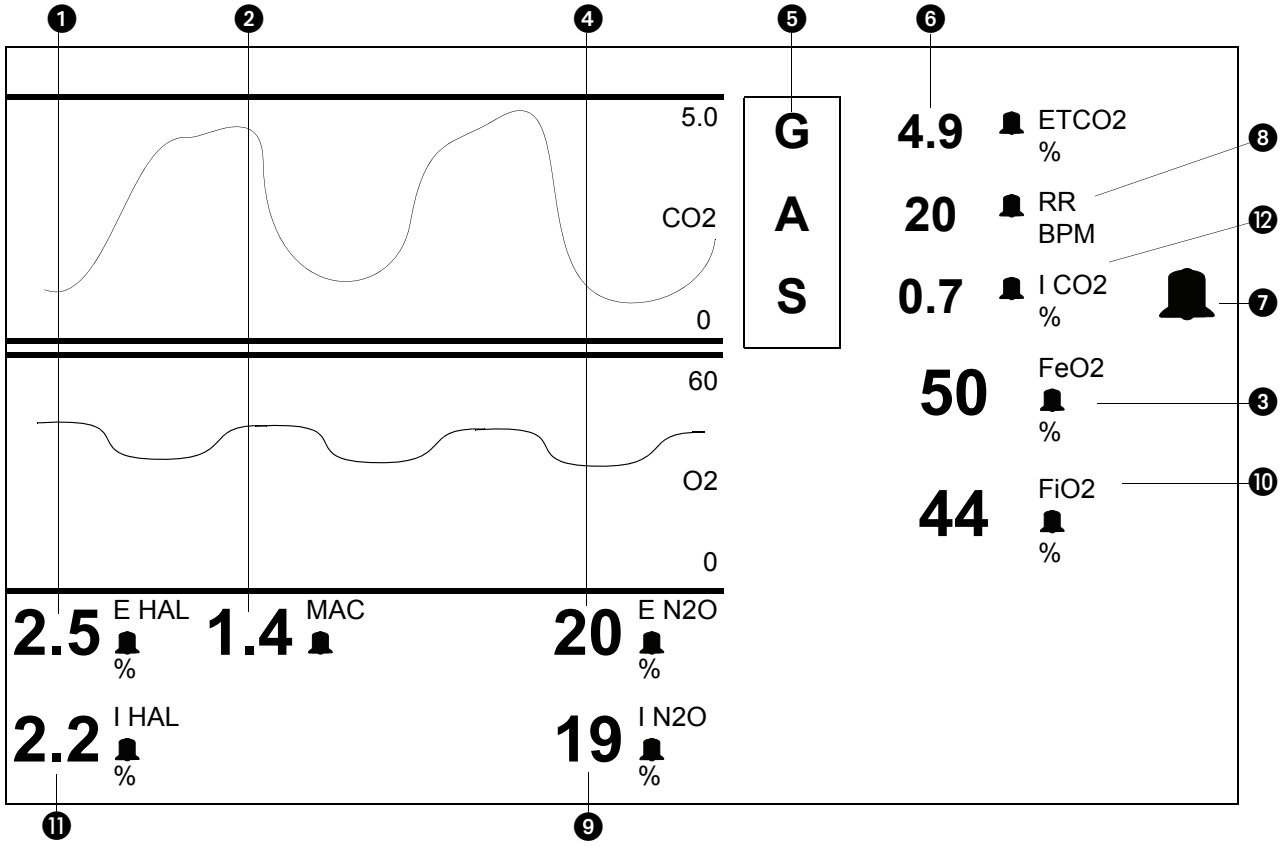



*Figure 25-8: Bedside display (two zones), CO2 and O2 waveforms ON*

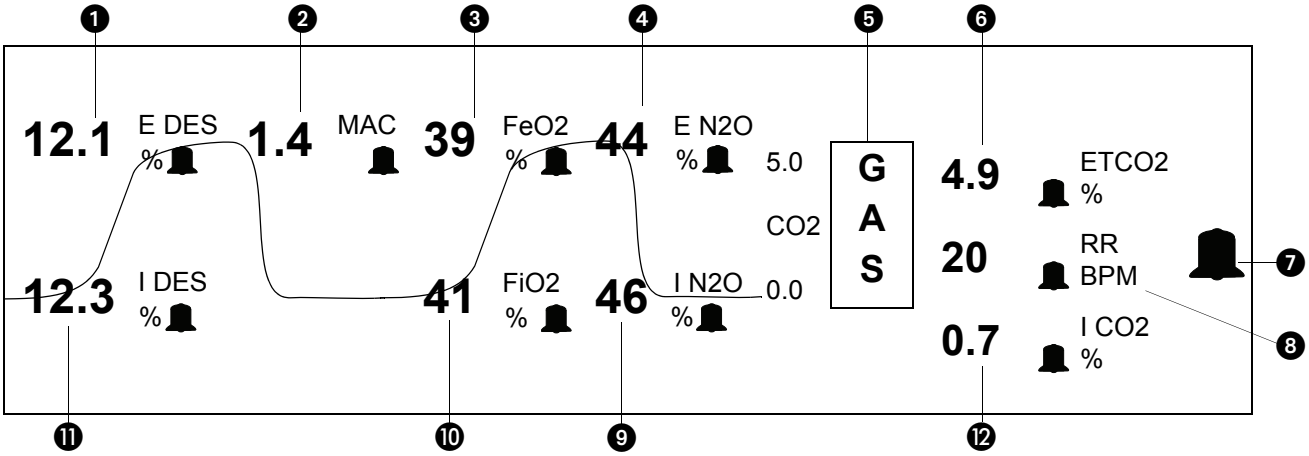



*Figure 25-9: Full-width remote view, CO2 waveform ON*

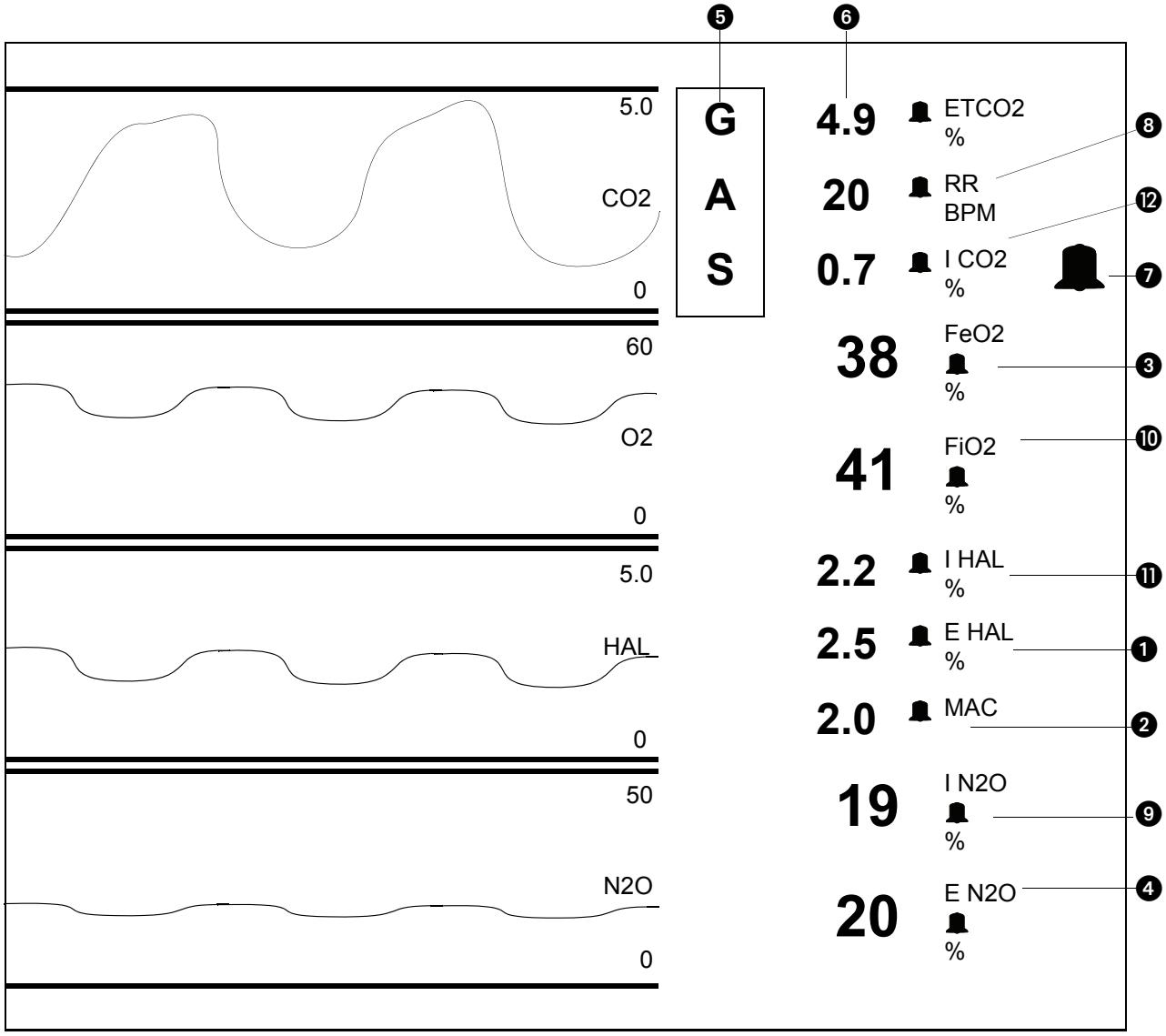



*Figure 25-10: Bedside display (four zones), all waveforms ON, two anesthetic agents*

*Figure 25-11* is the only available display option for remote displays.

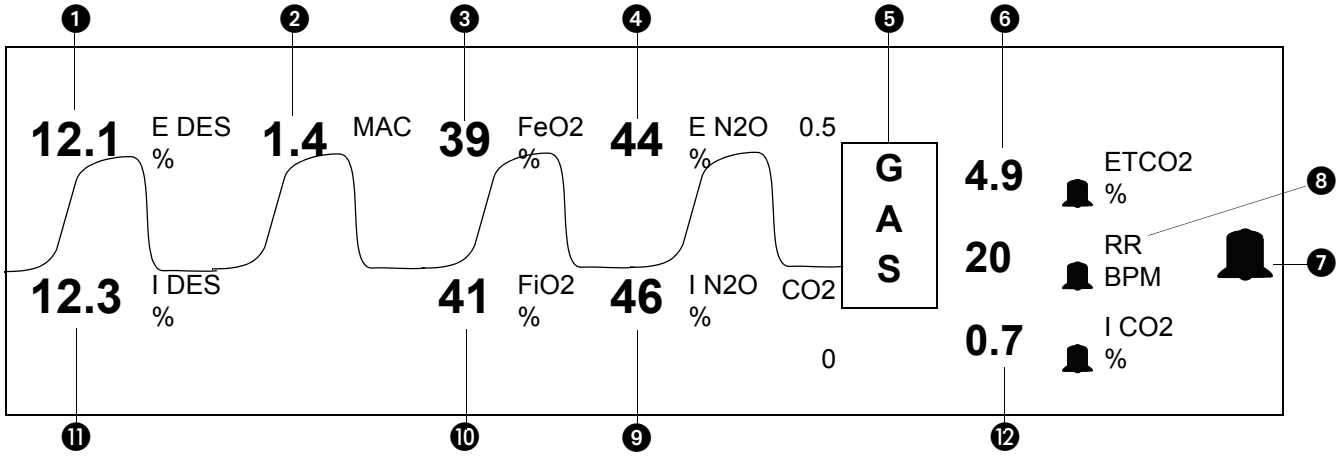



*Figure 25-11: Full-width central monitor or remote view, CO2 waveform ON*

The split-view display (refer to *Figure 25-12)* is available only on central monitors.

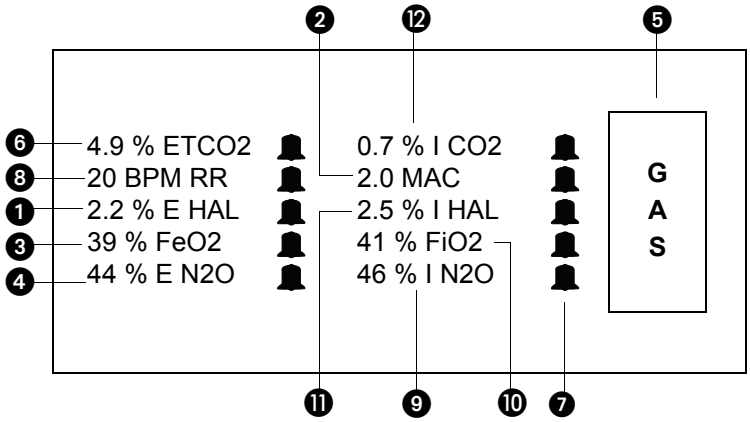



*Figure 25-12: Split-view central monitor display, CO2 waveform OFF*

1. Expired agent
2. MAC value (or AMAC, depending on user selection)
3. Fractional expired oxygen
4. Expired nitrous oxide
5. GAS parameter key
6. End-tidal carbon dioxide
7. Alarms status (refer to *Alarm Behavior* on page 25-23)
8. Respiratory rate
9. Inspired nitrous oxide

⑩ Fractional inspired oxygen

⑪ Inspired agent

⑫ Inspired carbon dioxide

## Alarm Behavior

The following behaviors are seen during all alarm conditions:

- The GAS key shall flash at all displays.
- Alarm Limits parameter key and HI or LO key shall flash at all displays.
- Large bell shall flash for Limit alarms at the local (bedside) and full-screen remote views.
- Parameter small bell shall flash at the local bed and split-screen view.
- Alarm tone shall sound at the local (bedside) and central (if enabled in MCM settings).
- Alarm Watch window shall display (if enabled in MCM settings).
- Alarm recording shall be initiated (if enabled in MCM settings).

# Changing the Display Format

You can select to display the expired or inspired values of parameters on the top line of the display. $ETCO_2$ values are always displayed on the top line.

**To display inspired/expired values on the top line:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT
- Select INSP TOP/EXP TOP.

***Note:***

*$EtCO_2$, $I\ CO_2$, RR, and MAC/AGEMAC display is not affected by INSP TOP/EXP TOP key.*

You can turn off the parameter's numeric display by touching the parameter's respective ON/OFF key. Selecting OFF will clear the parameter's numeric values from the display. You cannot turn off the numeric display for $FiO_2$, $EtCO_2$, and respiration rate.

**To turn OFF numeric displays:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch NUMERIC CONTROLS.
- Touch the ON/OFF key for the particular parameter.

The WAVEFORM CONTROLS menu controls the waveforms ON/OFF for $CO_2$, $O_2$, $N_2O$, and anesthetic agent parameters. $CO_2$ is available on all monitors. All other waveform control keys are available only on the local (bedside) monitor.

**To turn OFF waveform displays:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch WAVEFORM CONTROLS.
- Touch the ON/OFF key for the particular parameter.

For all parameters, except $EtCO_2$, the expired numeric values can be added to or removed from the display through each parameter's respective expired or inspired ON/OFF key in the NUMERIC CONTROLS MENU (for example, E N2O, ON/OFF). Setting this key to ON will display the related parameters' associated numeric (expired) values on the monitor.

## Two Agents

When two anesthetic agents are detected, the anesthetic agent with the higher concentration displays on the top line (numeric display only; refer to *Figure 25-6* on page 25-18), and its position is not user-configurable.

When a second anesthetic agent is no longer present, the display reverts to a single-agent display (refer to *Figure 25-5* on page 25-18).

## Mixed Agents

When a mixture of anesthetic agents is detected, and the analyzer is not able to identify the agents, an *AGENT  MEASUREMENT MAY BE UNRELIABLE* message displays and an alarm tone sounds.

During this condition, the anesthetic agent labels display as I MIX and E MIX. Inspired, expired, instantaneous numeric values display as questions marks (**???**).

## Unidentified Agents

If no anesthetic agent is identified in the system, the multigas module will display AA for the agent label and **??.?** for numeric values.

## No Breath Mode

The normal mode of operation is in effect as long as breathing is detected. When no breath has been detected for a duration equal to the APNEA alarm limit setting, the multigas module switches to no breath mode automatically.

When in no breath mode:

1 A NO BREATH DETECTED message displays in the $EtCO_2$ waveform zone.

2 An alarm tone sounds.

3 The ACKNOWLEDGE ALARMS key displays in the $EtCO_2$ waveform zone.

**To stop alarms in no breath mode:**

- Touch ACKNOWLEDGE ALARMS.

If the patient is not connected when gas monitoring is started, then the analyzer will remain in no breath mode.

During no breath mode, measurements of $CO_2$ , $O_2$ , $N_2O$, and the anesthetic agent(s) are continuously performed. Measurements referred to as instantaneous numeric values are displayed at one-second intervals in place of the inspired numeric values. Instantaneous numeric values can change with each display update.

In no breath mode, respiration rate (RR) and the expired values for $CO_2$ , $O_2$ , $N_2O$ and the anesthetic agents are displayed as **???**.

# Enabling and Adjusting Alarms

**The Alarm Limits menu allows you to enable and adjust alarm limits for the following:**

- RR (respiration rate) — high and low limits
- Apnea (delay is measured in seconds) — high limit
- $EtCO_2$ — high and low limits
- I $CO_2$ — high limit
- $FiO_2$ — high and low limits
- $FeO_2$ — high and low limits
- Inspired and Expired $N_2O$ — high and low limits
- Inspired and Expired Anesthetic Agent — high and low limits
- MAC — high and low limits
- AMAC — high and low limits

**To enable and adjust alarm limits:**

- Touch GAS.
- Touch ALARM LIMITS.
- Select a parameter.
- Touch ON for the parameter selected.
- Select the HI = or LO = key.
- Use the arrow keys to set the high and/or low alarm limit or the apnea alarm delay time.
- Touch a parameter key on the right side of the menu to cycle to the next parameter for setting alarm limits.
- Repeat the fourth through seventh steps above until all limits are set.

When the alarm is initially turned ON for $EtCO_2$ and RR, the limit values depend on the patient's current readings for those parameters (these limit values are learned). Alarm limits for all other monitored parameters, when turned ON, always have the same fixed values.

Default values appear for alarm limits when you initially power ON the multigas module, or when patient data is purged during patient admit/discharge. You can modify limits for any of the monitored parameters. These modifications will remain in effect until the unit is turned OFF. Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

*Table 2: Alarm Ranges*

| Parameter | Units | Low Alarm | | | High Alarm | | | Increments |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Default | Min. | Max. | Default | |
| **APNEA** | s | - | - | - | 20 | 45 | 20 | 5 |
| **RR** | bpm | 4 | 90 | Learned | 15 | 95 | Learned | 1 when ≤30<br>5 when >30 |
| **ETCO2** | mmHg | 0 | 119 | Learned | 1 | 120 | Learned | 1 |
| | kPa | 0 | 15.9 | | 0.1 | 16 | | 0.1 |
| | % | 0 | 14.9 | | 0.1 | 15 | | 0.1 |
| **I CO2** | mmHg | - | - | - | 1 | 40 | 8 | 1 |
| | kPa | - | - | - | 0.1 | 5.3 | 1 | 0.1 |
| | % | - | - | - | 0.1 | 5 | 1 | 0.1 |
| **FiO2** | % | 20 | 95 | 20 | 21 | 100 | 100 | 1 when ≤30<br>5 when >30 |
| **FeO2** | % | 15 | 95 | 18 | 16 | 100 | 100 | 1 when ≤30<br>5 when >30 |

*Table 2: Alarm Ranges (continued)*

| Parameter | Units | Low Alarm | | | High Alarm | | | Increments |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Default | Min. | Max. | Default | |
| **I N20** | % | 5 | 75 | 5 | 10 | 80 | 60 | 5 |
| **E N20** | % | 0 | 75 | 0 | 5 | 6 | 4 | 0.1 |
| **I HAL** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **E HAL** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **I ENF** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **E ENF** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **I ISO** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **E ISO** | % | 0 | 5.9 | 0 | 0.1 | 6 | 4 | 0.1 |
| **I SEV** | % | 0 | 7.9 | 0 | 0.1 | 8 | 6 | 0.1 |
| **E SEV** | % | 0 | 7.9 | 0 | 0.1 | 8 | 6 | 0.1 |
| **I DES** | % | 0 | 19.9 | 0 | 0.1 | 20 | 15 | 0.1 |
| **E DES** | % | 0 | 19.9 | 0 | 0.1 | 20 | 15 | 0.1 |
| **MAC** | - | 0 | 4.9 | 0 | 0.1 | 5 | 3 | 0.1 |
| **AGEMAC** | - | 0 | 4.9 | 0 | 0.1 | 5 | 3 | 0.1 |

*Table 3: Alarm Delays*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| Resp Rate High | 15 to 60 bpm | Less than 1 second |
| Resp Rate Low | 4 to 55 bpm | |
| Apnea | | Apnea alarm delay + 1 second |
| $EtCO_2$ High | 1 to 120 mmHg | Less than 1 second |
| $EtCO_2$ Low | 0 to 119 mmHg | |
| I $CO_2$ High | 1 to 40 mmHg | Less than 1 second |
| $FiO_2$ High | 21 to 100% | Less than 1 second |
| $FiO_2$ Low | 29 to 95% | |

*Table 3: Alarm Delays (continued)*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| $FeO_2$ High | 16 to 100% | Less than 1 second |
| $FeO_2$ Low | 15 to 95% | |
| $iN_2O$ High | 10 to 80% | Less than 1 second |
| $iN_2O$ Low | 5 to 75% | |
| $eN_2O$ High | 5 to 80% | Less than 1 second |
| $eN_2O$ Low | 0 to 75% | |
| iHAL High | 0.1 to 6% | Less than 1 second |
| iHAL Low | 0 to 5.9% | |
| eHAL High | 0.1 to 6% | Less than 1 second |
| eHAL Low | 0 to 5.9% | |
| iENF High | 0.1 to 6% | Less than 1 second |
| iENF Low | 0 to 5.9% | |
| eENF High | 0.1 to 6% | Less than 1 second |
| eENF Low | 0 to 5.9% | |
| iISO High | 0.1 to 6% | Less than 1 second |
| iISO Low | 0 to 5.9% | |
| eISO High | 0.1 to 6% | Less than 1 second |
| eISO Low | 0 to 5.9% | |

# Waveform Settings

Waveforms can be displayed for $CO_2$, $O_2$, $N_2O$ and anesthetic agents. Some display formats may be unavailable on some monitors. Refer to *Compatibility* on page 25-10. Turning on multiple waveforms expands the display and increases the number of waveforms in use.

If more zones are selected than are available, the GAS key appears at the bottom of the display, in the numeric key zone. When you touch the GAS numeric key, the GAS parameter is displayed in the lowest-priority display zone.

CO2 MODE displays only the $CO_2$ waveform and the numeric values in a single zone (refer to *Figure 25-9* on page 25-20). When CO2 MODE is ON, the CO2, O2, N2O, and anesthetic agent keys on the **Waveform Controls menu** are disabled.

You can turn OFF the waveforms for $CO_2$, $O_2$, $N_2O$ and anesthetic agents and display only the numeric values. When all waveforms are OFF, the SCALE, SWEEP SPEED, and FREEZE ON/OFF keys are disabled.

If a parameter's waveform is too large to fit within the screen zone, use the parameter's waveform scale keys to adjust the waveform size.

To freeze the waveform screen, set the FREEZE key to ON. When you freeze the waveform, numeric information continues to be updated. The waveform stays frozen until you touch FREEZE / OFF or touch the NORMAL SCREEN key. The SCALE, SWEEP SPEED, and WAVEFORM CONTROLS keys are disabled when waveforms are frozen.

The sweep speed determines the speed at which the waveform moves across the screen. Available sweep speeds are 25, 12.5, 6.25, 3.12, or 1.56 mm/second.

**To turn CO2 MODE ON or OFF:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch WAVEFORM CONTROLS.
- Touch CO2 MODE ON or OFF.

**To turn the waveform ON or OFF for a particular parameter:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch WAVEFORM CONTROLS.
- Touch ON or OFF for the particular parameter.

***Note:***

*Waveform controls are disabled when CO2 Mode is ON. To turn waveforms ON or OFF, CO2 Mode must be set to OFF.*

**To adjust the waveform scale size:**

- Touch GAS.
- Touch SETUP.
- Touch SCALE.
- Touch the parameter you wish to change.
- Select the desired scale size.

**To freeze all waveform screens:**

- Touch GAS.
- Touch FREEZE / ON.

**To select a sweep speed (for all waveforms):**

- Touch GAS.
- Touch SETUP.
- Touch SWEEP SPEED.
- Select the desired sweep speed.

# MAC and AGEMAC Calculations

You can select mean alveolar concentration (MAC) calculations to be a MAC only calculation, or you can select AGEMAC for MAC calculations based on patient age. When AGEMAC is selected, the patient age is displayed, except on the split-screen display.

If the patient age is not available, the calculation will default to MAC, and the MAC/AGEMAC key will be disabled. The MAC/AGEMAC value will display **???** if the expired values of $N_2O$ and the anesthetic agent are unavailable.

**To select MAC or AGEMAC:**

- Touch GAS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch MAC or AGEMAC.

## MAC Calculations

$$MAC(AA) = \frac{\%EAA}{\times(AA)}$$ (should be calculated for first and second agents)

$$MAC(N2O) = \frac{\%EN2O}{\times(N2O)}$$

$$MAC = MAC(AA) + MAC(N2O)$$

**Where:**

AA = any of five anesthetic agents: HAL, ENF, ISO, SEV, or DES

MAC(AA) = Calculated value of MAC for a given AA

MAC(N2O) = Calculated value of MAC for $N_2O$

EAA = Expired value of AA

EN2O = Expired value of $N_2O$

×(AA) = Agent-specific coefficient, as follows: HAL=0.75%, ENF=1.7%, ISO=1.15%, SEV=2.05%, DES=6%

×(N2O) = 100, the coefficient for $N_2O$

**For example:**

If ENF = 1%, SEV = 1%, and $N_2O$ = 20%

MAC(AA) = 1/1.7 + 1/2.1 = 1.064

MAC(N2O) = 20 / 105 = 0.19

MAC = 1.064 + 0.19 = 1.254 (The result would be rounded to 1.3)

## AGEMAC Calculations

$$AGEMAC(AA) = \frac{MAC(AA)}{[(0.05 \times TEMP - 0.85) \times (1.32 \times 10^{(-0.00303 \times AGE)})]}$$

$$AGEMAC(N_2O) = \frac{EN2O}{[114 \times 1.378 \times 10^{(-0.00347 \times AGE)}]}$$

$$AGEMAC = AGEMAC(AA) + AGEMAC(N2O)$$

**Where:**

AGEMAC(AA) = AGEMAC value calculated based on AA

AgeMAC(N2O) = AGEMAC value calculated based on $N_2O$

TEMP = Body temperature of the patient. If temperature is not available, then use a value of 37° C

AGE = Patient age

AGEMAC = Calculated value of AGEMAC

**For example:**

If ENF = 1%, SEV = 1%, $N_2O$ = 20%, TEMP = 35, and AGE = 50

MAC(AA) = (1/1.7) + (1/2.1) = 1.064

AGEMAC(AA) = $1.064 / [(0.05 \times 35 - 0.85) \times (1.32 \times 10^{(-0.00303 \times 50)})] = 1.27$

AGEMAC(N2O) = $20 / (114 \times 1.378 \times 10^{(-0.00347 \times 50)}) = 0.19$

AGEMAC = 1.27 + 0.19 = 1.46 (The result would be rounded to 1.5)

# Printing the Gas Waveform Zone

You can print multigas values. Refer to *Printing* on page 9-5 for additional information.

**To print the gas waveform zone:**

- Touch GAS.
- Touch PRINT.

***Note:***

*The PRINT key is available at all monitors.*

# Selecting a Unit of Measurement

$CO_2$ values and alarm limits can be displayed as a percentage (%) or as units of pressure. The units of pressure are either mmHg or kPa, depending on the monitor setup.

To select units of measurement, touch the PERCENT/mmHg (or PERCENT/kPa) key until the desired unit is highlighted.

**To select a measurement unit:**

- Touch GAS.
- Touch SETUP.
- Select PERCENT or mmHg (or kPa, depending on the monitor's setting).

# Suspending and Resuming Sampling

**Sampling can be suspended by touching the SUSPEND SAMPLING key under the following conditions:**

- When suctioning a patient.
- When use (by the patient) is temporarily discontinued.
- When nebulized drugs are being used.

This stops the sampling pump and keeps the system free of debris. When sampling is suspended, the ZERO key on the **Calibration menu** is disabled. The analyzer remains warmed up so that no additional warm-up time is required. Touch the RESUME SAMPLING key to resume sampling.

***Note:***

*The SUSPEND SAMPLING key is available only at the local/bedside monitors.*

**Caution:**

**Sampling must be resumed for proper monitoring of respiratory gases.**

**To suspend sampling:**

- Touch GAS.
- Touch SUSPEND SAMPLING.
- Touch RESUME SAMPLING to resume sampling.

# Calibrations

***Warning:***

- ***Calibrations must be performed by qualified service engineers.***
- ***The calibration should occur when the multigas module is not actively monitoring a patient.***

## Auto Zero Calibration (Zeroing)

The 92518 Multigas Module performs zeroing automatically by switching the gas sampling from the respiratory circuit to ambient air. The automatic zeroing is performed every 24 hours and takes less than 10 seconds for the multigas module to complete.

***Warning:***

***Since a successful zeroing requires the presence of ambient air (21% $O_2$ and 0% $CO_2$) in the module, ensure that the module is placed in a well ventilated place. Avoid breathing near the sidestream gas analyzer before or during the zeroing procedure.***

If the module is fitted with an oxygen sensor, the automatic zeroing also includes room air calibration of the oxygen sensor.

To guarantee accurate readings, the zero reference of the multigas module is automatically calibrated on a regular basis. Auto zero calibrations last less than 15 seconds. During auto zero calibrations, the *AUTO ZERO IN PROGRESS* message displays.

The interval between auto zero calibrations depends on the amount of time the multigas module operates.

The infrared gas analyzer needs to establish a zero reference level for the $CO_2$, $N_2O$, and anesthetic agent gas measurement.

# Gas Calibration

A gas calibration is recommended when gas values appear to be too low or too high. A gas calibration is required when the O2 CALIBRATION REQUIRED message displays.

***Warning:***

- ***Performing a gas calibration without the calibrated gas mixture connected adversely affects the accuracy of the multigas module.***
- ***Gas calibrations must be performed by trained personnel only.***
- ***Gas calibrations must be performed with 100% $O_2$ concentration.***

The gas calibration procedure is used to recalibrate the gas channels for $O_2$.

Refer to the *Multigas Module 92518 Service Manual* (P/N 070-2362-xx) for details on calibrating the multigas module.

***Note:***

*Waveforms and numeric values may disappear during calibration.*

## Gas Span Calibration

**To calibrate gas spans:**

1. Allow the analyzer to warm up for at least one minute.
2. Make sure that the surrounding gas is normal air (21% $O_2$ and 0% $CO_2$).
3. Ensure that there is no breath detected and that all expired numerics and **RR** display **???** (refer to *Figure 25-13*).
4. Touch GAS, then CAL to enter the GAS - CALIBRATION MENU.
5. Touch the SERVICE CAL key five times (SERVICE CAL is a hidden key).
6. Supply the calibration gas with 100% $O_2$ into the sample line.

   Observe and wait until the **O2** display is almost stable on the display page in the SERVICE CAL menu.
7. Once the gas display is stable, touch **100% O2 Cal**.
8. Touch YES to proceed with the $O_2$ calibration.
9. The message CAL GAS IN PROGRESS appears.

   This message may display for 15 seconds or until the calibration is complete.
10. The message CAL GAS COMPLETED displays when a successful calibration is complete.
11. The message CAL GAS FAILED displays if the calibration process fails.

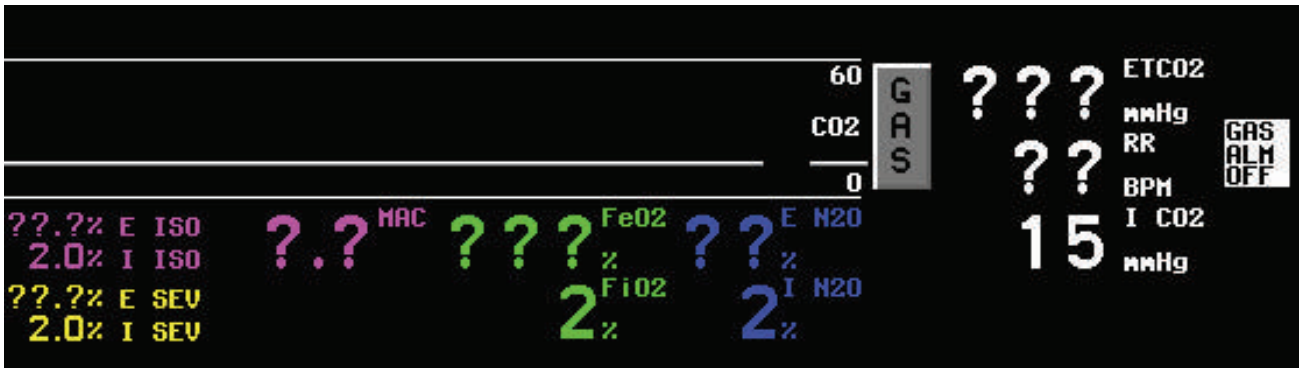



*Figure 25-13: Before calibration—??? display for expired numerics and RR.*

**To verify a successful calibration:**

1 Touch NORMAL SCREEN, enable the O2 waveform, and check the following:

a The **O2** numerics display 100% in the case of gas supply (refer to *Figure 25-14*).

-OR-

b The **O2** numerics display 21% in the case of room air supply.

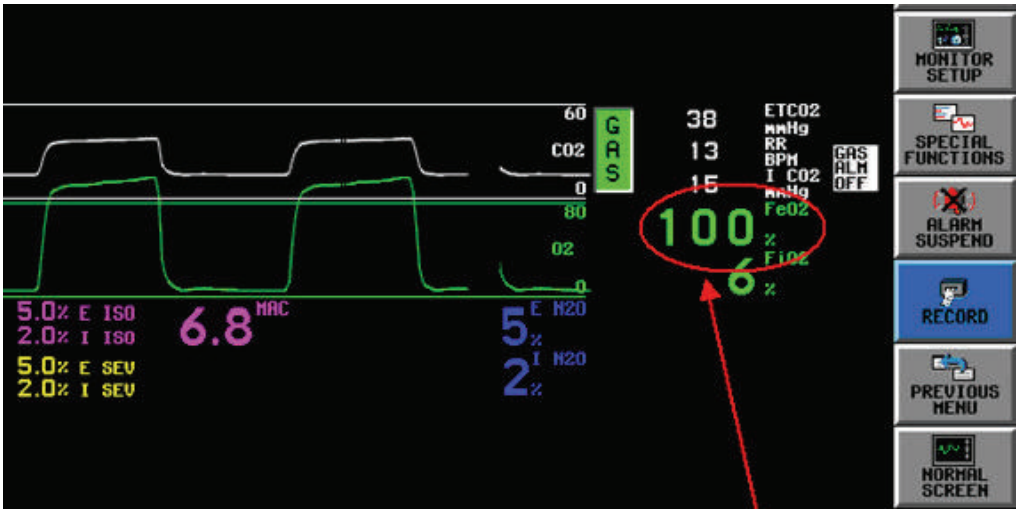



*Figure 25-14: Proper display of O2 numerics upon successful calibration.*

# 92518 Multigas Troubleshooting Guide

The multigas module displays error messages in the gas waveform zone. Many of these messages also trigger an alarm, if configured to do so. If the prompt line is available, the monitor displays messages there as well.

**Caution:**

**Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

***Note:***

*Depending on the severity of the error, the multigas module may not analyze sampled gases while the monitor displays any of these messages. Numeric values are always available for a specific waveform if that numeric is not turned off.*

Whenever a gas calibration failure occurs, the previous calibration factors are not lost. The multigas module continues to function and report the gas values, but the full accuracy of the values is not guaranteed.

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **Module does not sign on** | ■ Defective hardware. | ■ Contact a qualified field service engineer. |
| | ■ Flash memory programming error, or defective software on the interface board. | ■ Contact a qualified field service engineer. |
| **Module does not power up** | ■ Improper insertion of the module into the bay. | ■ Remove and reinsert the module.<br>■ Unplug and replug in the monitor |
| | ■ Defective hardware. | ■ Contact a qualified field service engineer. |
| **SENSOR OVER TEMPERATURE** | ■ The operating environment temperature is too high. | ■ Use the multigas module only within its intended operating temperature range of 10° to 40° C.<br>■ Contact a qualified field service engineer, and return the unit to Spacelabs Healthcare for repair if the message persists. |
| **SAMPLE LINE OCCLUDED** | ■ The sample line is blocked. | ■ Disconnect and reconnect the sample line.<br>■ Check the sample line for blockages or crimps; replace as necessary. |

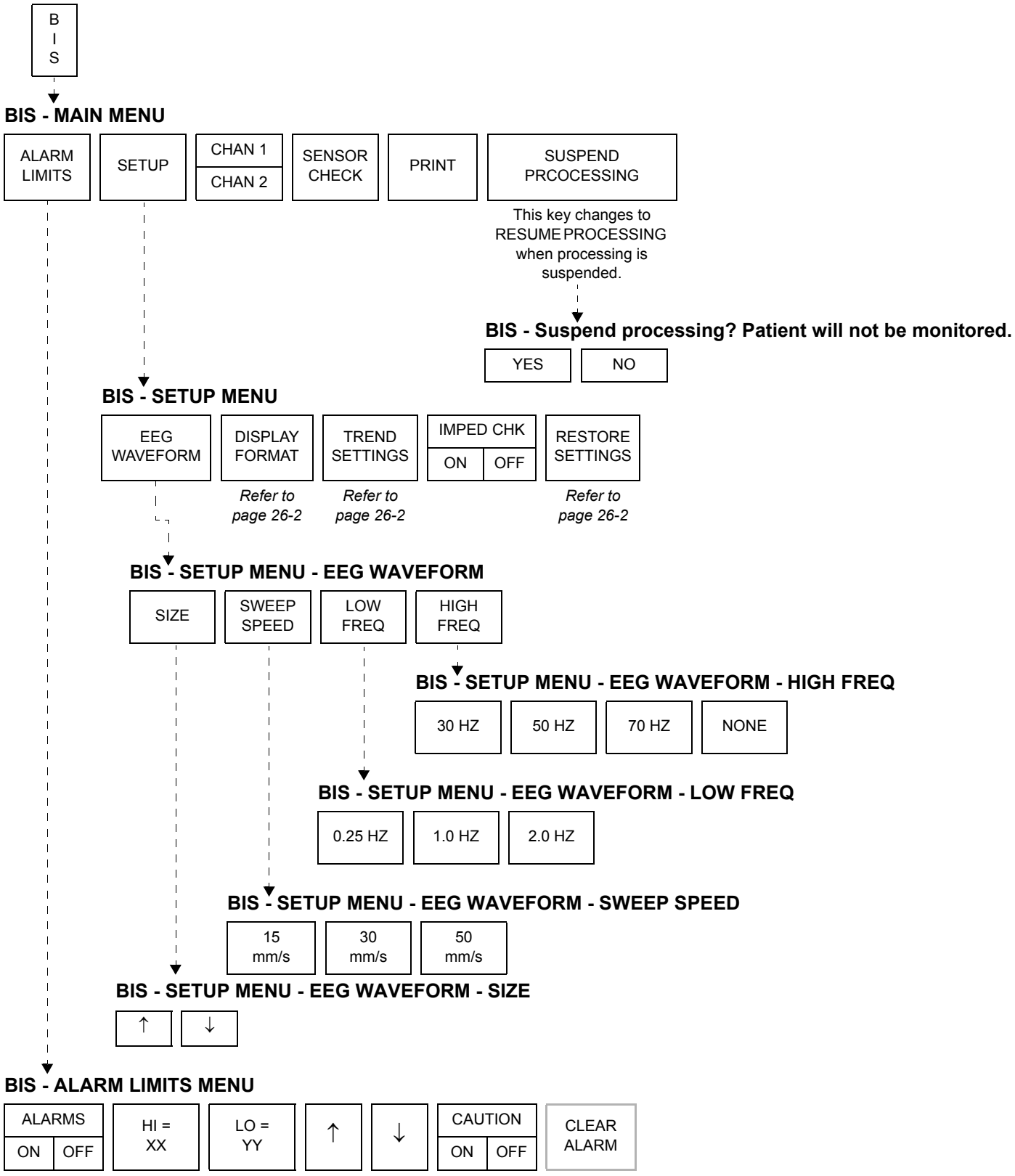
| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **COMMUNICATION LINK LOST - Service required -OR- COMMUNICATION DROP OUTS - Service required** | ■ An internal communication problem was detected. | ■ Contact qualified field service personnel and return the unit to Spacelabs Healthcare for repair. |
| **SERVICE CAL MODE - Patient is not monitored** | ■ The SERVICE CAL menu is displayed on the bedside monitor. | ■ Touch NORMAL SCREEN to exit this mode on the bedside monitor. |
| **SAMPLING SUSPENDED - Patient is not monitored** | ■ Sampling was suspended by the user by pressing the SUSPEND SAMPLING or END CASE key. | ■ Touch RESUME SAMPLING or START CASE to exit this mode on the bedside monitor. |
| **NO BREATH DETECTED** | ■ Breaths are not detected for a duration equal to the APNEA timeout duration. | ■ Verify sensor is properly connected to the patient. Message will clear after a valid respiratory rate is detected, or the ACKNOWLEDGE ALARMS key is touched. |
| **Inspired values fluctuate over a wider and more extreme range than what is expected.** | ■ Analyzer is in no breath mode. | ■ Verify sensor is properly connected to the patient. Message will clear after a valid respiratory rate is detected, or the ACKNOWLEDGE ALARMS key is touched.<br>■ To exit this mode, if the ACKNOWLEDGE ALARMS key is not present:<br>1 Touch the GAS key.<br>2 Touch SUSPEND SAMPLING, then touch YES.<br>3 Touch RESUME SAMPLING, then touch YES. |
| **NO BREATH message appears constantly and red alarm indicator flashes.** | ■ Physiological cause<br>■ Clogged or blocked filter line.<br>■ Filter line caught in something or tube is kinked. | ■ Check the patient.<br>■ Check the sample line and replace if blocked.<br>■ Check the sample line from the module to the patient to see if the line is kinked, twisted, or caught in the bed or equipment. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **AUTO ZERO IN PROGRESS** | ■ An automatic zero or manual zero calibration is in progress. | ■ Wait for the message to disappear. |
| **CAL GAS IN PROGRESS** | ■ CAL GAS calibration is in progress. | ■ Wait until the CAL GAS calibration is successfully completed. The message disappears. |
| **CAL GAS FAILED - Check gas supply** | ■ The unit could not calibrate the gas channel. | ■ Repeat the calibration. Contact your biomed or qualified field service personnel if the CAL GAS fails again. |
| **SENSOR WARMING UP** | ■ The unit is warming up. | ■ Wait until warm up completes before operating. |
| **AMBIENT PRESSURE OUT OF NORMAL OPERATION RANGE** | ■ The atmospheric (ambient) pressure exceeds the multigas module environmental operating requirements. | ■ Check the multigas module environmental operating requirements in the *92518 Multigas Module* data sheet (P/N 061-2530-xx). |
| **AGENT MEASUREMENT MAY BE UNRELIABLE.** | ■ A mixture of anesthetic agents is detected, and the analyzer is not able to identify the agents. | ■ The multigas module is not designed to simultaneously identify and measure more than two anesthetic agents. Inaccurate numeric concentration values may be displayed when agents are mixed. Depending on the agents used, the residue in the breathing or delivery system, and the concentration left in the patient's lungs, a mixed agent condition can last for more than an hour.<br>■ If the message persists, contact your biomed or qualified field service personnel. |
| **Sample line connected but pump not working and no $CO_2$, $EtCO_2$, or RR readings are shown.** | ■ Sample line not plugged in properly. | ■ Check the plug's connection at the monitor.<br>■ Check that the sample line is connected properly at the module; replace as necessary.<br>■ Remove and reattach the sampling line. |

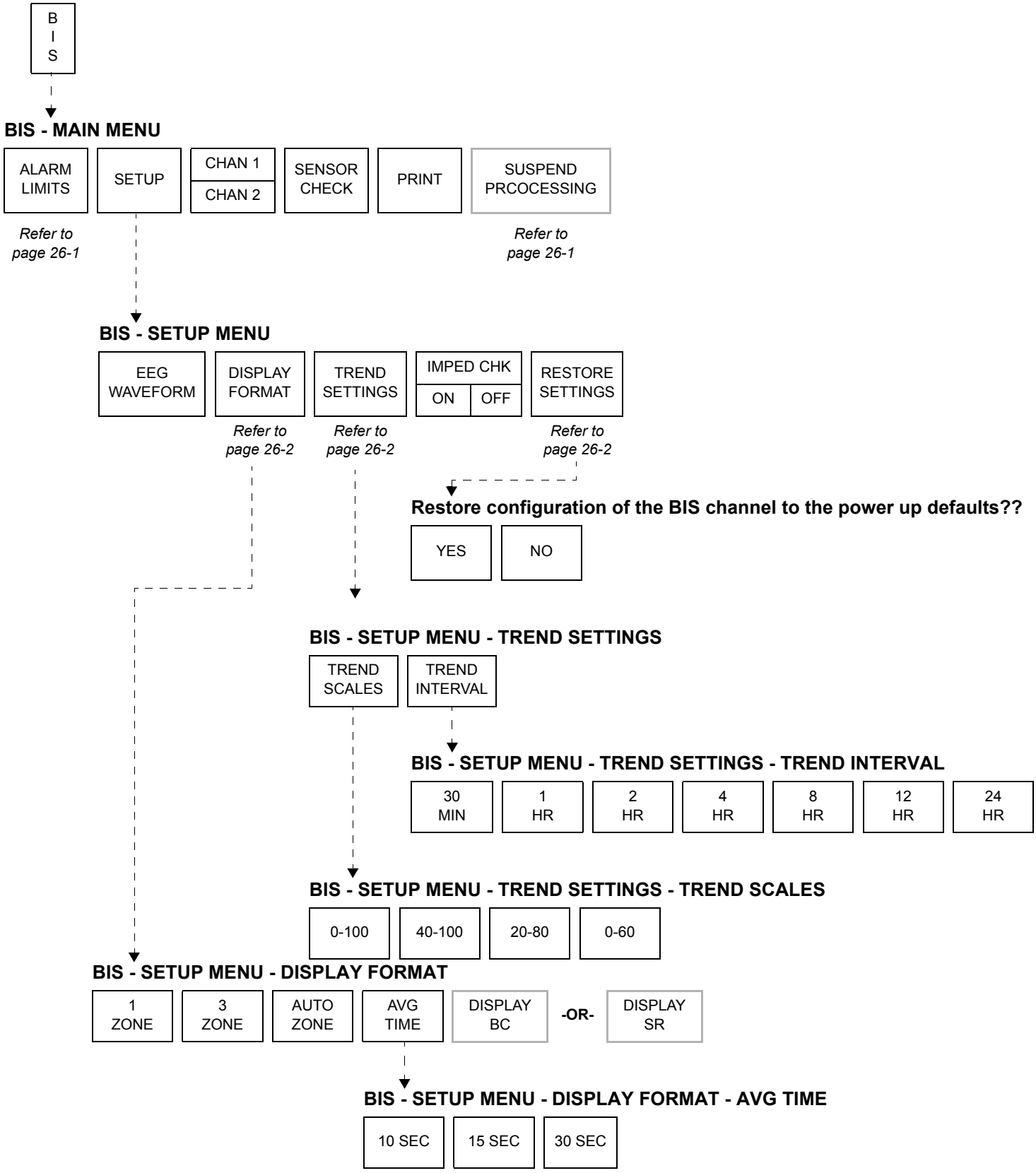
| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **No sampling line** | ■ Sample line not plugged in properly. | ■ Remove and check the sample line. |
| **Error: Maintenance required** | ■ Hardware or sensor error. | ■ Contact a qualified field service engineer. |
| **O2 CALIBRATION REQUIRED** | ■ Recommended O2 sensor calibration. | ■ Enter the GAS - SERVICE CAL menu at the display to calibrate the O2 sensor. |

# BISx

## Directory of Keys



## SETUP MENU Continued



# BISx

## Contents


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## Overview

The Spacelabs Healthcare 91482 BISx™ module acquires real-time electroencephalogram (EEG) data for adult and pediatric patients and processes it into a Bispectral Index® (BIS®) number between 0 and 100. BIS analysis is a mathematical calculation derived from the frequency, power, and phase throughout the entire frequency range of the EEG.

**The following additional parameters associated with the EEG data are also displayed:**

- Suppression Ratio (SR)

  Suppression ratio gives the user an indication when an iso-electric (flat-line) EEG condition may exist. Suppression ratio is the percentage of time over the last 63 seconds that the signal is considered to be in the suppressed state. For example, an SR of 11 means the signal was iso-electric over 11% of the last 63 seconds. At an SR of 100%, the message ISO-ELECTRIC EEG DETECTED will notify the user. The range for SR is between 0 and 100%.

- Spectral Edge Frequency (SEF)

  SEF is the frequency at which 95% of the total power of the EEG lies below that frequency, and 5% lies above it. The range is between 0.50 and 30 Hz.

- Median Power Frequency (MF)

  MF is the frequency (measured in Hz) at which 50% of the total power of the EEG lies below that frequency, and 50% lies above it. The frequency range is between 0.5 and 30 Hz.

- Electromyographic strength (EMG)

  The power (in dB) from electrical activity of the muscles and other high-frequency artifacts, in the frequency range of 70 to 110 Hz. Values are between 25 to 100 dB, with respect to 1 $\mu V^2$ = 40 dB. BIS monitoring conditions are optimal at 25 dB. Movement may indicate inadequate analgesic level.

- Signal Quality Index (SQI)

  SQI is the percentage of good epochs in the last 120 epochs (61.5 seconds) that are used to calculate the Bispectral Index and spectral variables. Values are not affected by the suppression ratio, and range from 0 and 100.

  The SQI is a measure of the signal quality for the EEG channel source and is calculated based on impedance data, artifact, and other variables. When signal quality is too low to accurately calculate a BIS value, the BIS value and other trend variables that are adversely affected by artifact will not be displayed on the screen.

- Burst Count (BC) (only when using the BIS Extend sensor)

  Burst Count is an alternative method of quantifying suppression, and is available only when a BIS Extend Sensor is in use. The system defines a “burst” as a short period of EEG activity, preceded and followed by periods of inactivity. Computed from suppression data, it is reported as the number of EEG bursts per minute. The Burst Count is displayed at the top of the screen, and may also be graphed as a secondary variable on the BIS Trend Graph. Values are between 0 and 30. When the signal quality is low, or when the Suppression Ratio is less than 5, the Burst Count is not displayed.

# Indications for Use

The Spacelabs Healthcare Bispectral Index (BISx) Analysis Module 91482 is intended for use under the direct supervision of a licensed healthcare practitioner or by personnel trained in its proper use. It is intended for use on adult and pediatric patients within a hospital or medical facility providing patient care to monitor the state of the brain by data acquisition of EEG signals.

The Spacelabs Healthcare Bispectral Index (BISx) Analysis Module 91482 may be used as an aid in monitoring the effects of certain anesthetic agents. Use of BIS monitoring to help guide anesthetic administration may be associated with the reduction of the incidence of awareness with recall in adults during general anesthesia and sedation.

# Warnings and Cautions

This chapter includes warnings and cautions specifically related to BISx monitoring. Refer to *Warnings and Cautions* on page 31-6 in the *Product Specifications* chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

# Setup

Connect the BISx pod as shown in *Figure 26-1*. Refer to the sections that follow for descriptions of each part. Insert the BISx module into the Spacelabs Healthcare monitor.

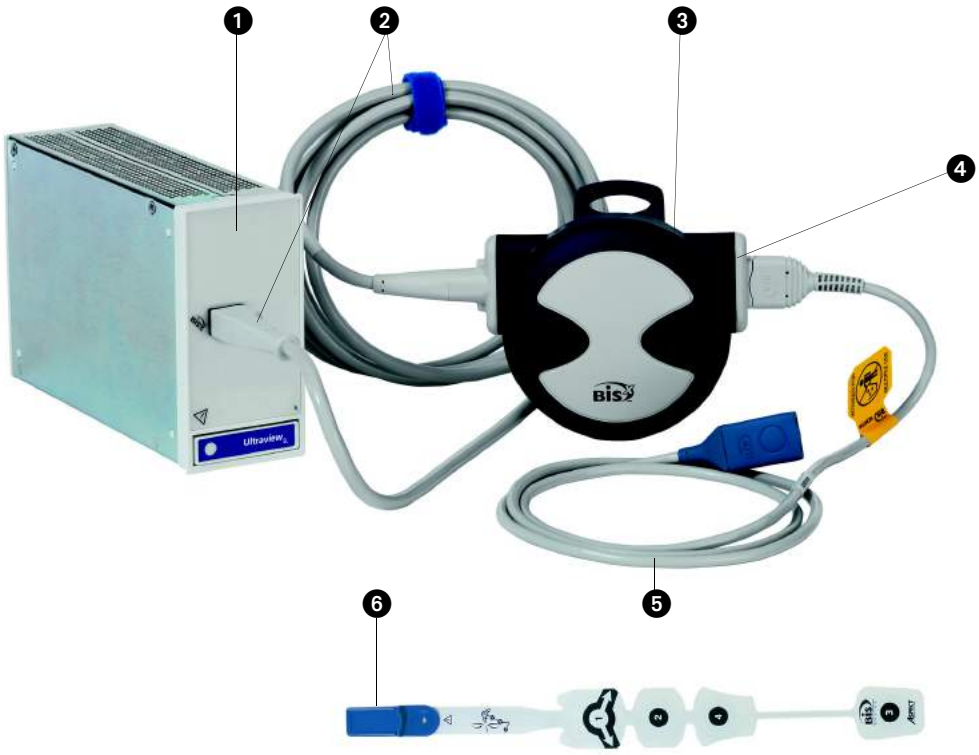



*Figure 26-1: BISx system*

1. BISx module
2. Host monitor cable (module to pod)
3. BISx pod
4. PIC connector
5. Patient interface cable (pod to BIS sensor)
6. BIS sensor

## BISx Pod

The BISx pod contains the input connector, amplifiers, and digital signal converter. The pod receives the EEG input from the patient and converts it to digital information that is processed by the module. Plug the host monitor cable into the BISx module as shown in *Figure 26-1*.

**To connect the BISx pod to the BISx module:**

- Locate the host-monitor cable connector end.
- Plug the host monitor cable into the BISx module.

***Note:***

*The BISx pod is protected against the effects of a cardiac defibrillation discharge (type BF defibrillation-proof applied part), and it is safe to use on patients with a cardiac pacemaker or other electrical stimulation.*

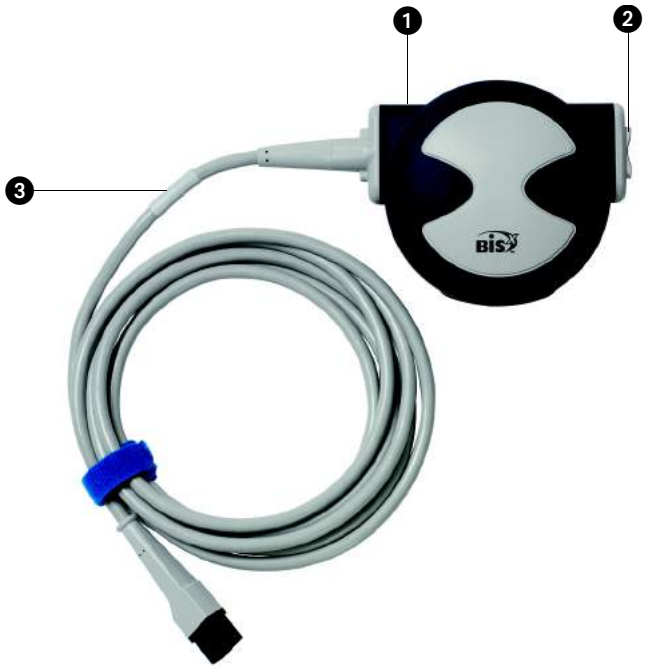



*Figure 26-2: BISx pod*

1. BISx pod
2. PIC connector
3. Host monitor cable (to module)

### Pod Placement

The BISx pod includes a clip on the underside for attaching the pod. Clip the pod to an IV pole, a bed rail, or a bed sheet.

### Caution:

**Because of the elevated surface temperature of the BISx pod, do not place the pod in direct contact with the patient.**

## Patient Interface Cable (PIC)

The PIC provides connection between the BISx pod and the BIS sensor.




*Figure 26-3: PIC*

1. Sensor connector
2. Pod connector

***Note:***

*The PIC is not a disposable cable. Do not dispose of it when you dispose of the attached BIS sensor (unless the cable is faulty or damaged).*

**To attach the PIC to the BISx pod:**

- Locate the pod connector on the end of the PIC.
- Connect the pod connector to the pod's PIC connector, ensuring that it is fully seated.
- Clip the pod to an IV pole, bed rail, or bed sheet.

# BIS Sensors

### Caution:

**Refer to Electrodes, Lead Wires, Sensors, and Sensor Cables on page 31-8 and page 31-9 for cautionary disclosures.**

The BIS sensor is a patient-connected, single-use sensor that must be disposed of after each use. Dispose of the sensor according to your hospital protocol.

BIS sensors have electrodes numbered one to four that are applied in particular positions on the patient's forehead.

***Note:***

*You can attach the BIS sensor to the PIC before or after the sensor is placed on the patient.*

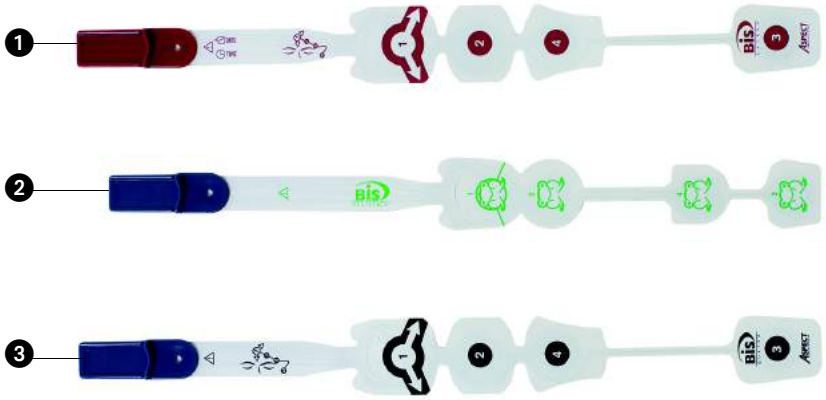


*Figure 26-4: BIS sensors*

1. BIS Extend sensor (red print)
2. BIS Pediatric sensor (green print)
3. BIS Quatro sensor (blue print)

***Note:***

*The BIS Pediatric, Quatro, and Extend sensors and the PIC sensor connector are mechanically keyed to connect in only the correct way. BIS Standard sensors used with the 90482 BIS module should not be used with the 91482 BISx module.*

**To attach the BIS sensor to the PIC:**

- Remove the BIS sensor from its packaging.
- Insert the sensor tab into the PIC the sensor connector (blue end).

# Patient Preparation

***Warning:***

***Do not expose the BIS sensor to surgical skin preparation solutions. This may result in harm to the patient's skin.***

**Caution:**

- **The BIS sensor only functions when placed on the patient's forehead. It should not be used with any surgical procedure that precludes such placement.**
- **Make sure the patient's forehead skin surface is clean and dry before applying the sensor. Ensure that the sensor expiration date, which is printed on the sensor packaging, has not elapsed.**

**To prepare the patient for monitoring:**

- Wipe the patient's forehead with alcohol and then dry.
- Apply the sensor to the patient's forehead according to the sensor packaging.
- Insert the sensor tab into the PIC sensor connector (if not already connected).

## Sensor Application

Refer to the sensor packaging and application instructions for directions on applying the BIS sensor to the patient.

# Starting BIS Monitoring

When the module is powered ON, it will initiate a system test to verify that the equipment and connections are operating properly. If a problem occurs, the system will halt and display a status message. Refer to *BISx Troubleshooting and Status Messages* on page 26-18 for status messages.

## Starting a Patient Case in the Operating Room

The BISx module matches its case with the Spacelabs monitor it is being used with. When used with monitors that do not support START CASE/END CASE, BIS monitoring begins when the patient connection is made.

When used with a monitor that supports START CASE, ensure that all patient and equipment connections have been made, and then touch the START CASE key on the monitor.

**To start a BIS case in the operating room:**

- Ensure all patient connections have been made.
- Touch START CASE (if necessary).

***Note:***

*The label of this key on the supporting monitor toggles between START CASE and END CASE with each touch.*

## Starting a Patient Case in the Intensive Care Unit

Monitors used in an ICU or other critical care setting may not support the START CASE/END CASE function.

When used with monitors that do not support START CASE/END CASE, BIS monitoring begins when the patient connection is made.

The module will automatically perform an impedance check. An electrode status display appears under SENSOR CHECK on the right of the display (refer to *Figure 26-5*). Refer to *Impedance Check* on page 26-13 for more information.

***Note:***

*It is not necessary to touch SENSOR CHECK to test electrode placement, because a sensor check is performed automatically when the sensor is connected to the BISx module.*

## Suspending and Resuming BIS Monitoring

When you press SUSPEND PROCESSING, the message displays with a YES/NO confirmation. The key changes to RESUME PROCESSING when processing is suspended.

**To suspend BIS monitoring:**

- Touch BIS.
- Touch SUSPEND PROCESSING.
- Touch YES or NO.

**To resume BIS monitoring:**

- Touch BIS.
- Touch RESUME PROCESSING.
- Touch YES or NO.

# Display Detail

You can select to display the three-zone display (refer to *Figure 26-5*) or the one-zone display (refer to *Figure 26-6*). The three-zone display shows the BIS and EMG trends.

The factory default display setting is AUTO ZONE. AUTO ZONE switches between the three-zone display when the you touch the BIS parameter key and the one-zone display when the BIS key is not selected.

When monitoring BIS on a monitor limited to three or four waveforms, BIS should be set to the one-zone display.

Refer to *Entering Setup Information* on page 26-15 for information on selecting a display format.

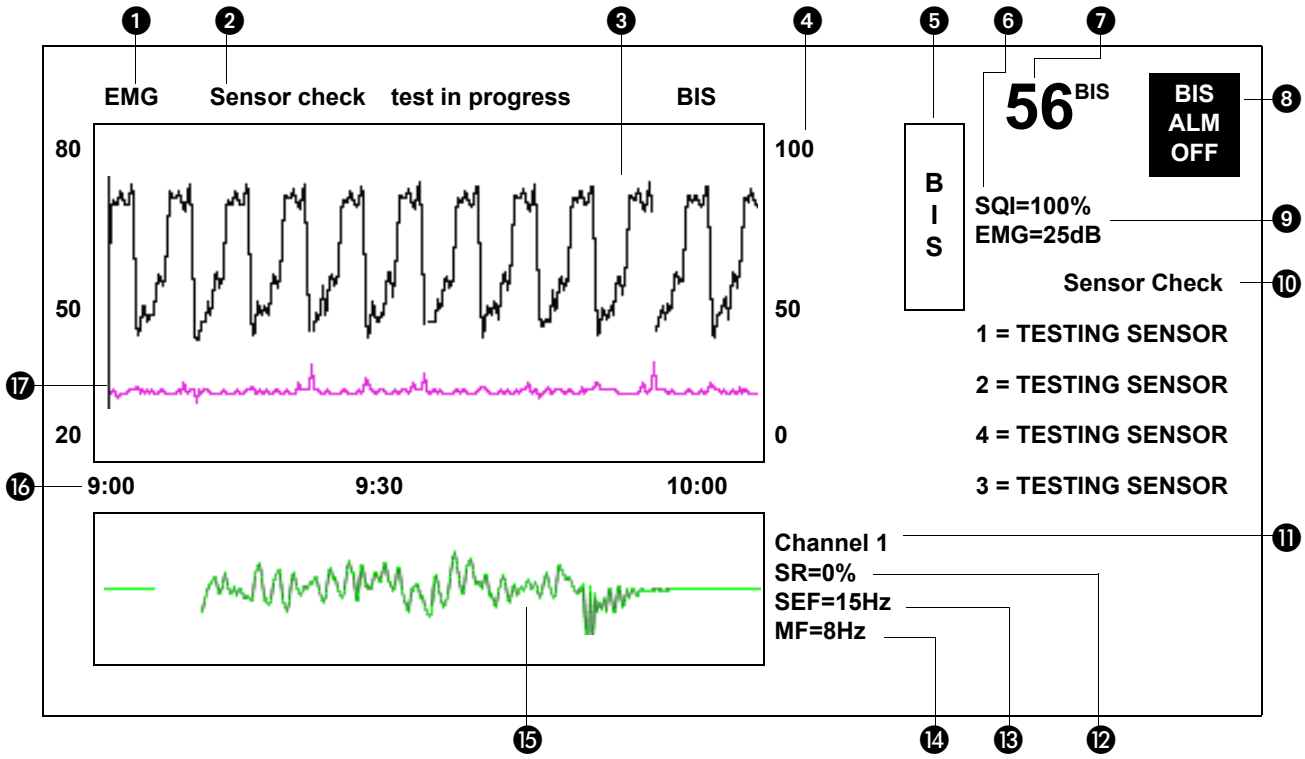



*Figure 26-5: Bedside monitor (three zones) during impedance test*

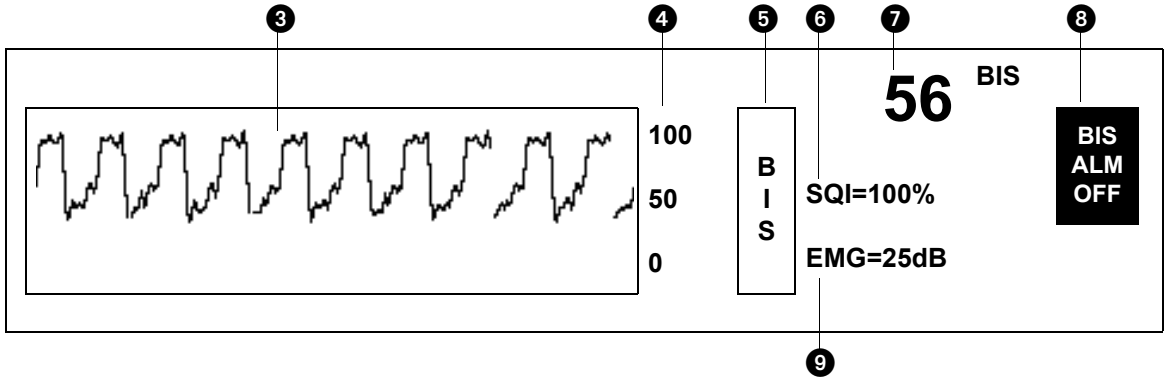



*Figure 26-6: Bedside monitor (one zone) and remote view display*

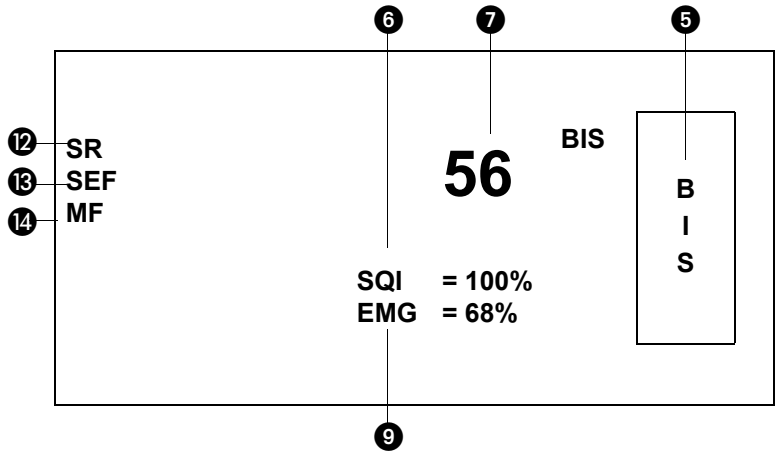



*Figure 26-7: Central monitor split-view display*

1. EMG scale range
2. Status message
3. BIS trend
4. BIS scale range
5. BIS parameter key
6. SQI (Signal Quality Index)
7. BIS value
8. BIS alarm status — BIS ALM OFF appears when alarms are turned OFF. The high and low alarm limit values appear when alarms are turned ON.
9. EMG (Electromyogram)
10. Electrode Status — This message appears when a sensor impedance check is in progress. Refer to *Impedance Check* on page 26-13.
11. EEG Channel 1/Channel 2 — Details which of the two available waveforms are displayed.

⓬ SR (Suppression Ratio)

⓭ SEF (Spectral Edge Frequency)

⓮ MF (Median Power Frequency)

⓯ EEG real-time waveform

⓰ Time axis

⓱ EMG trend

## Averaging Time

The BIS trend can appear jagged, with many peaks or artifacts. Select a longer averaging time to smooth the appearance of the trend. Select a shorter averaging time for a more responsive BIS value.

**To change the averaging time:**

- Touch BIS.
- Touch SETUP.
- Touch DISPLAY FORMAT.
- Touch AVG TIME.
- Select the desired averaging time (10 SEC, 15 SEC, 30 SEC).

## Remote View Display Format

The Remote View option enables you to view the BIS parameter from a remote monitor. One screen zone is used to display the BIS information, regardless of the type and the number of zones that are in use at the bedside monitor. EEG waveforms are not available in this mode (refer to *Figure 26-6*).

When viewing the BIS parameter from a remote monitor, the lower part of the BIS trend is not visible because remote monitors use this area to display the bed name and patient identification information.

***Note:***

*In the remote view, only the ALARM LIMITS, SETUP, and PRINT keys are active. All other keys are disabled.*

## Impedance Check

An impedance ground test automatically occurs every 10 minutes. You can perform an impedance check during BIS monitoring without losing your trended data.

**To initiate a sensor impedance test:**

Touch SENSOR CHECK.

During an impedance check, an electrode status display appears under **Sensor Check** on the right of the display (refer to *Figure 26-5*), and the IMPEDANCE TEST IN PROGRESS message appears.

The electrode status displays the following:

- The individual sensor electrode (1, 2, 3, or 4);
- The status (PASS/HIGH/LEAD OFF/CLIP); and
- The impedance value for that electrode (in kΩ).

***Note:***

*All processing is suspended until the impedance test stops and the SENSOR CHECK key is available again.*

When an impedance value exceeds the threshold, the value flashes on the screen. If the impedance value is too high, it may indicate that the BIS sensor is no longer making good contact and needs to be examined or replaced.

***Note:***

*The user cannot control the impedance thresholds.*

The SENSOR CHECK key is unavailable during impedance testing. The impedance test automatically concludes when all electrodes complete impedance testing.

Automatic impedance testing can be turned OFF if it is causing interference with other devices, such as an EEG module.

**Caution:**

**If background impedance checking is turned OFF, the BISx system will not detect any BIS sensor-related faults.**

**To turn OFF automatic impedance testing:**

- Touch SETUP.
- Touch IMPED CHK /OFF.

# Enabling and Adjusting Alarms

Touch ALARM LIMITS to display the **Alarm Limits** menu.

**From this menu, you can:**

- Turn the BIS alarms ON or OFF
- Set the upper and lower BIS alarm limits
- Turn the CAUTION alarm ON or OFF

Refer to *Setting Alarm Limits on page 7-7* for details on operating system alarms.

The BIS HI and LO alarm limits display as numeric values when alarms are ON. The messages BIS ALM OFF displays in place of the alarm values when alarms are OFF.

The caution alarm warns you when the BIS value is within five units of either the HI or LO alarm limit. When the BIS value is within the caution zone, the BIS number flashes.

***Note:***

*No tone is emitted for the caution alarm.*

If a BIS alarm is active when BIS value becomes undefined, such as if a cable becomes disconnected, the BIS value displays as question marks (??) and the alarm will continue. To clear the alarm, press the CLEAR ALARM key.

**To turn alarms ON or OFF:**

- Touch BIS.
- Touch ALARM LIMITS.
- Touch ALARMS ON/OFF.

**To adjust alarm limits:**

- Ensure that alarms are ON.
- Touch HI= or LO=.
- Use the arrow keys to raise or lower the alarm limit.

**To enable or disable the caution alarm:**

- Ensure that alarms are ON.
- Touch CAUTION ON/OFF.

**To clear an alarm:**

- Touch BIS.
- Touch ALARM LIMITS.
- Touch CLEAR ALARM.

# Entering Setup Information

**The Setup menu enables you to control the following functions:**

- Select a display format (one zone or three zones)
- Adjust the vertical scale for the trended BIS value
- Select the time interval for the BIS and EMG trends, to indicate the total number of hours represented by the *x*-axis of the trend screen
- Adjust the size of the EEG waveform
- Select a screen sweep speed for the EEG waveform

**To access the Setup menu:**

- Touch BIS.
- Touch SETUP.

**To select a display format:**

- Touch DISPLAY FORMAT.
- Select 1 ZONE, 3 ZONE, or AUTO ZONE.

**To select burst count (BC) display when using a BIS Extend sensor:**

- Touch DISPLAY FORMAT.
- Touch DISPLAY BC to display the burst count (only available when monitoring using a BIS Extend sensor).

**To select a trend range:**

- Touch TREND SETTINGS.
- Touch TREND SCALES.
- Select the desired scale range.

**To select a trend interval:**

- Touch TREND SETTINGS.
- Touch TREND INTERVAL.
- Select the desired interval.

**To adjust the EEG waveform size:**

- Touch EEG WAVEFORM.
- Touch SIZE to adjust the amplitude scale of the EEG waveform.
- Use the arrow keys to increase or decrease the amplitude value.

To optimize the quality of the EEG waveform, or to reduce distortion, you can adjust the EEG high-frequency and low-frequency settings.

**To adjust the EEG low-frequency setting:**

- Touch EEG WAVEFORM.
- Touch LOW FREQ.
- Select the desired low frequency setting.

**To adjust the EEG high-frequency setting:**

- Touch EEG WAVEFORM.
- Touch HIGH FREQ.
- Select the desired high frequency setting.

# Printing the Screen

Touch the PRINT key to print the BIS and EMG trends. Current numeric information appears on the printout. The printout identifies the bed name, patient name, time, and date of the printout. Refer to *Printing* on page 9-5 for additional information.

**To print the screen:**

- Touch BIS.
- Touch PRINT.

***Note:***

*The PRINT key does not print the EEG real-time waveform. Press the RECORD key on the monitor and then touch the BIS parameter key to print the EEG waveform.*

# BISx Alarm Delays

*Table 1: BISx Alarms*

| Alarm Setting | Range | Alarm Delay |
|---|---|---|
| BISx High | 5 to 100 | Less than 1 second |
| BISx Low | 0 to 95 | |

# BISx Troubleshooting and Status Messages

**Caution:**

**Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

The BISx module displays status messages in the waveform zone and on the message line.

***Note:***

- *Status messages display in the waveform zone if you are displaying the three-zone format, or on the monitor's prompt line if you are displaying the one-zone format.*
- *Processing may be suspended when any of these messages display.*
- *The numeric data may be displayed as question marks.*
- *The EEG waveform may contain artifacts.*

Status message will continue to display until all faults are corrected.

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **Module does not sign on** | ■ Defective hardware. | ■ Contact a Spacelabs Healthcare Field Service Engineer. |
| | ■ Flash memory programming error, or defective software on the interface board. | ■ Contact a Spacelabs Healthcare Field Service Engineer. |
| **BIS CABLE NOT CONNECTED** | ■ The cable is not connected to the BISx pod or the BISx module. | ■ Check that the cable is connected to the pod and that the connector is fully connected to the module. The pod may require service if it is connected but does not work. |
| **THIS MONITOR DOES NOT SUPPORT BIS** | ■ A newer monitor is required to use the BISx module. | ■ Use a newer monitor with the BISx module. |
| **HARDWARE ERROR SERVICE MODULE** | ■ The BISx pod may be defective. | ■ Return the pod to Spacelabs Healthcare for service. |
| **BIS ABORT—RESTART MODULE** | ■ Too many errors (overcurrent, voltage regulation) have occurred with the BISx pod. The module has stopped trying to communicate with the pod. | ■ Remove the BISx module, then insert it to power cycle the module. If this problem persists, the BISx pod and/or module may require service. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **BIS TEST IN PROGRESS** | ■ The system is performing a self-test of the BISx module; the BISx pod has been connected or disconnected. | ■ No action is necessary. |
| **ILLEGAL PATIENT INTERFACE CABLE ID** | ■ An unrecognized patient interface cable has been connected to the BISx pod. | ■ The PIC may be defective. Replace the PIC. |
| **PIC NOT CONNECTED** | ■ The PIC may be disconnected from the BISx pod.<br>■ The PIC may be defective.<br>■ The sensor is faulty or incompatible. | ■ Check the cable connections.<br>■ Check the PIC. Replace if necessary.<br>■ Check sensor for compatibility or replace sensor. |
| **SENSOR CHECK TEST PASSED** | ■ The sensor check test has passed. The module is ready to collect data. | ■ No action is necessary. |
| **SENSOR CHECK TEST FAILED** | ■ The sensor check test has failed. The module will not collect data until the impedance test passes. | ■ Check that all the electrodes are properly applied.<br>■ Check the PIC. Replace if necessary. |
| **SENSOR CHECK TEST IN PROGRESS** | ■ The sensor check test is in progress. The test duration is 10 to 15 seconds. | ■ No action is necessary. The test duration is 10 to 15 seconds. |
| **IMPEDANCE TEST FAILED** | ■ The BIS sensor has an impedance that is too high. | ■ If the message persists, check the impedance of the sensor.<br>■ Replace sensor as necessary.<br>■ Replace the PIC as necessary. |
| **BAD SIGNAL QUALITY**<br><br>**The primary trend variable cannot be calculated** | ■ The signal quality index is unacceptable (<15%) due to interference. The interference may be the result of motion or the presence of electrocautery devices. | ■ Check BIS sensor placement and connection. |

| Clinical Situation or Message | Possible Cause | Solution |
|---|---|---|
| **POOR SIGNAL QUALITY**<br><br>**The numeric display blinks** | ■ The signal quality index is poor (≥15% but <50%) due to interference. The interference may be the result of motion or the presence of electrocautery devices. | ■ Check BIS sensor placement and position. |
| | ■ The patient has just been connected to the monitor, and the monitor is collecting the initial data. | ■ No action is necessary. |
| **ISO-ELECTRIC EEG DETECTED** | ■ No discernible EEG activity is detected for several minutes; SR = 100. | ■ Check the patient.<br>■ Check the BIS sensor for proper connection. |
| **TOO MANY USES, REPLACE SENSOR** | ■ The BIS sensor is designed for single use. | ■ Attach a new sensor to the sensor cable. |
| **INVALID/FAULTED SENSOR, REPLACE** | ■ An invalid sensor has been attached to the PIC, or a sensor overcurrent/positive/ negative ground fault has occurred. | ■ Attach a valid sensor to the PIC, then detach and reattach the BISx pod to the module. |
| **SENSOR EXPIRED, CHECK PERFORMANCE** | ■ The conductive gel on BIS sensors has degraded. Sensor performance may be compromised if the sensor is used after its expiration date. | ■ Perform and impedance check. If the sensor passes impedance check, it can be used. If the sensor does not pass, replace the sensor. |
| **NOTE: XX USES REMAINING** | ■ The cable has a limited number of uses. “XX” denotes number of uses remaining. | ■ No action is necessary |

# Calculations

## Directory of Keys




*Refer to Introduction*

*Trends/Calcs must be enabled*

*Refer to Alarms*

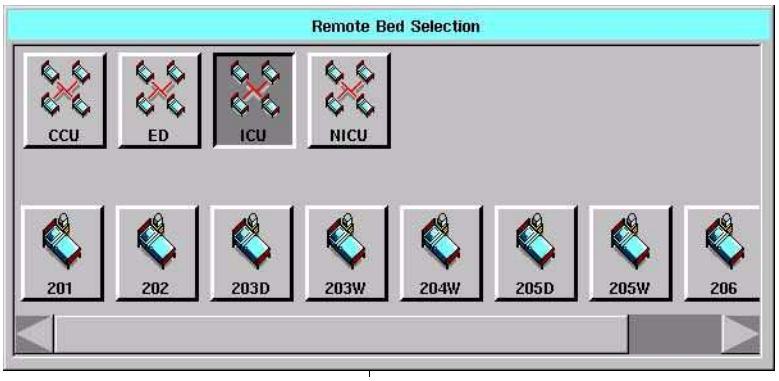
*Refer to Printing*

*Refer to Introduction*

**SPECIAL FUNCTIONS**

LOCAL TRENDS/ CALCS

REMOTE TRENDS/CALCS




**TRENDS/CALCS for BED xxx**

CALCS

*Refer to page 27-2*

DRUG CALCS

*Refer to page 27-3*

# Clinical Calculations

**TRENDS/CALCS for BED xxx**

CALCS | DRUG CALCS

*Refer to page 27-3*

**CLINICAL CALCS for BED xxx**

HEMO CALCS | RESP CALCS | OXY CALCS | RENAL CALCS | UPDATE DATA

**X CALCS - Select a menu key**

NEW ENTRY | EDIT INPUTS | EDIT DAY/TIME | STORE ENTRY | DELETE ENTRY | PAGE / SCROLL | ⇐ | ⇒ | PRINT

**HEMO CALCS EDIT INPUTS MENU - Select input to change**

| HR | MAP | CVP | MPA | PCWP | BSA | CO |
|---|---|---|---|---|---|---|
| bts/min | mmHg | mmHg | mmHg | mmHg | m2 | L/min |

**RESP CALCS EDIT INPUTS MENU - Select input to change**

| RR | PaCO2 | VT | PIP | PLT | PEEP | PECO2 |
|---|---|---|---|---|---|---|
| br/min | mmHg | ml/br | cmH20 | cmH2O | cmH2O | mmHg |

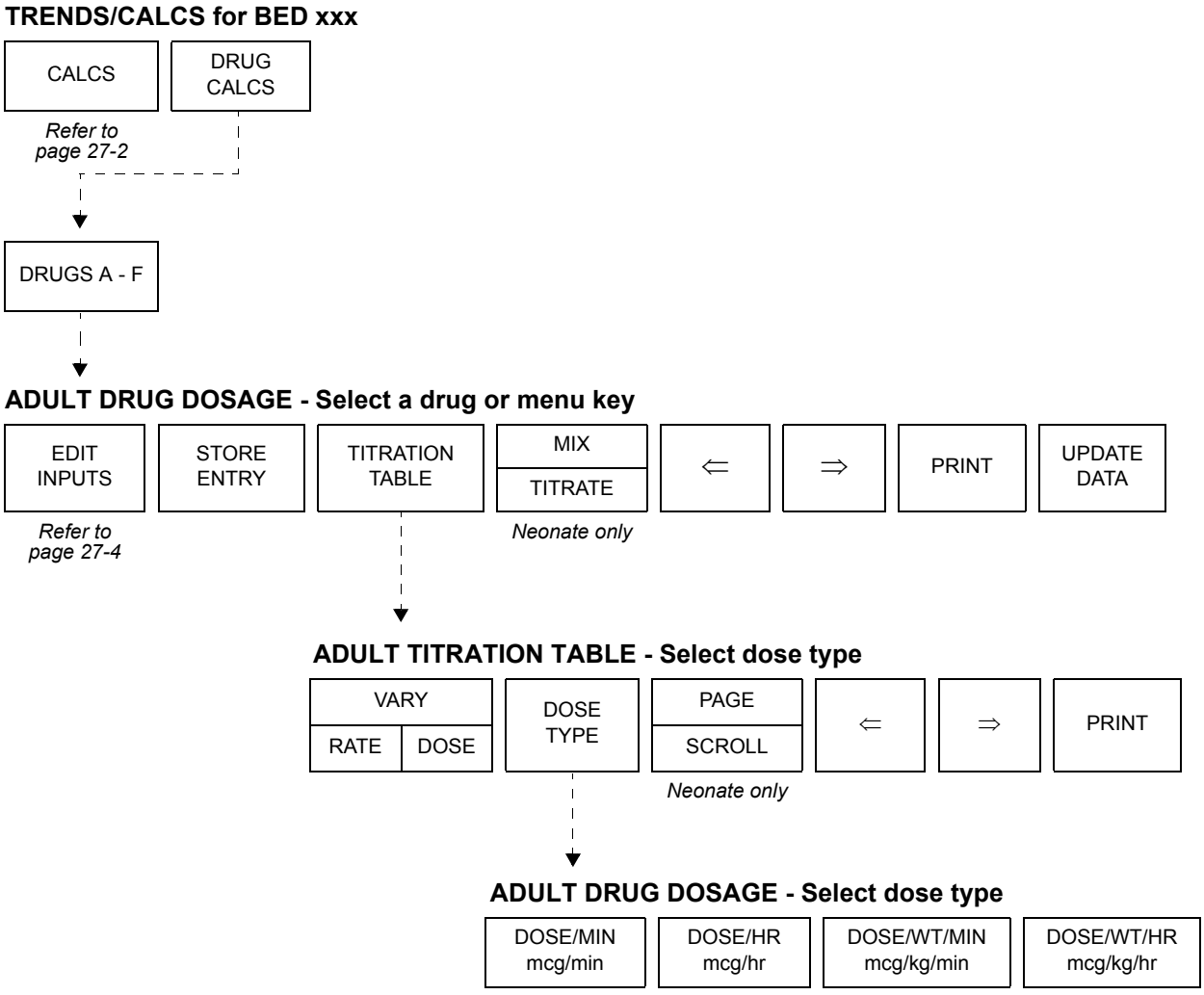
**OXY CALCS EDIT INPUTS MENU - Select input to change**

| FIO2 | PaO2 | SpO2 | PaCO2 | PvO2 | SvO2 | Hgb | PB | CO | BSA |
|---|---|---|---|---|---|---|---|---|---|
| % | mmHg | % | mmHg | mmHg | % | g/dl | mmHg | l/min | m2 |

**RENAL CALCS EDIT INPUTS MENU - Select input to change**

| URK | PLOSM | UROSM | SerNa | CR | UCR | BUN | URNa | URINE | BSA |
|---|---|---|---|---|---|---|---|---|---|
| mEq/L | mOsm/L | mOsm/L | mEq/L | mg/dl | mg/dl | mg/dl | mEq/L | ml/day | m2 |

# Drug Dosage Calculations



# Drug Dosage Calculations (continued)

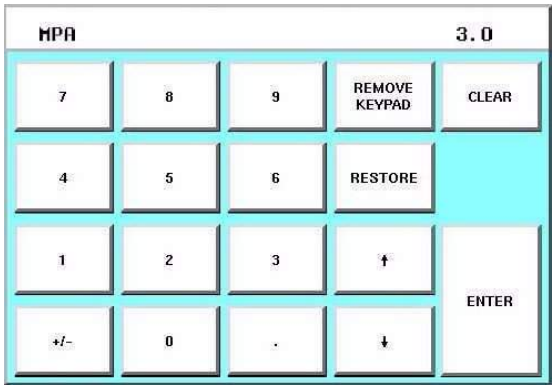
*(Refer to page 27-3)*

**EDIT INPUTS MENU - Select input to change**

DRUG | UNITS | AMT | VOL | CONC | WEIGHT | DOSE | RATE | DUR | TOTAL DOSE | TOTAL VOL

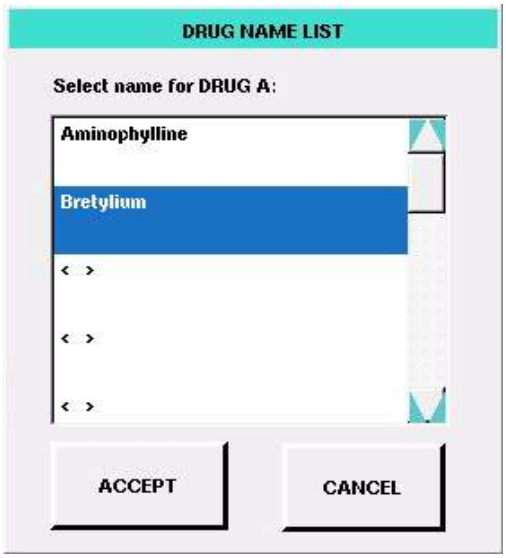
**ADULT DRUG DOSAGE - Select dose type**

DOSE/MIN mcg/min | DOSE/HR mcg/hr | DOSE/WT/MIN mcg/kg/min | DOSE/WT/HR mcg/kg/hr




**Select units**

AMOUNT / DOSE | mcg | mg | g | mEq | units | k units | m units



# Calculations

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## Overview

**The Calculations feature can be divided into two types:**

- Clinical or Physiologic (refer to *Display Detail — Physiologic Calculations* on page 27-6)
- Drug Dosage (refer to *Setting Up Drug Dosage Calculations* on page 27-19)

Physiologic calculations include hemodynamic, respiration, oxygenation, and renal. These calculations use input values entered manually, or collected automatically by the system, to produce a set of output values.

Drug Dosage calculations enable you to determine infusion rates for drugs, based on drug concentration, desired dose, patient weight, and patient type (adult or neonate).

The UPDATE DATA key is used to synchronize calculation data between multiple monitors. For example, if lab data for calculations were entered at the central monitor and stored in the bedside monitor database, using the UPDATE DATA key would provide those values for calculations performed at the bedside.

# Accessing Calculation Data

Calculations can be accessed via the local bedside monitor or from a remote monitor on the network, depending upon the options purchased. Contact your system administrator for details if you are unable to access this function. The data displayed in the Calculations table is from the selected monitor.

Values are entered into the system in several ways. You can take a snapshot of currently monitored inputs by selecting the NEW ENTRY key (refer to *Creating a New Entry* on page 27-8). You can also specify a day and time to gather input data from the past, although this function is generally limited to the past 24 hours.

***Note:***

*If the monitor is turned OFF, all calculations data will be lost.*

**To access physiologic or drug dosage calcs:**

- Touch SPECIAL FUNCTIONS.
- Touch LOCAL TRENDS/CALCS or REMOTE TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, then select a bed.
- Touch CALCS or DRUG CALCS.

# Display Detail — Physiologic Calculations

**The system displays a combined total of 200 entries into the four physiologic calculations tables:**

- Hemodynamic (refer to *Hemodynamic Calculations* on page 27-12)
- Respiration (refer to *Respiration Calculations* on page 27-15)
- Oxygenation (refer to *Oxygenation Calculations* on page 27-16)
- Renal (refer to *Renal Calculations* on page 27-18)

Each table has an **Edit Inputs Menu** to edit the input data. You can also create a record of both input and output data by printing the displayed table.

Tables for physiologic calculations occupy several display zones above the message line, allowing waveforms to appear on the remaining zones of the display.

Seven columns of data (records) can be displayed on the display at one time. The date, hour, and minute displayed in the day/time key at the top of the column indicate when that record's information (which is displayed below the key) was acquired. Hours can be displayed in either a 12-hour or 24-hour format, depending on the system setup. An A (for a.m.) or a P (for p.m.) follows the minute value when you use the 12-hour format.

The table's dividing line separates a record's calculation inputs from its calculated outputs. The calculation inputs above the dividing line were automatically collected or manually entered. The calculated output values are displayed below the dividing line.

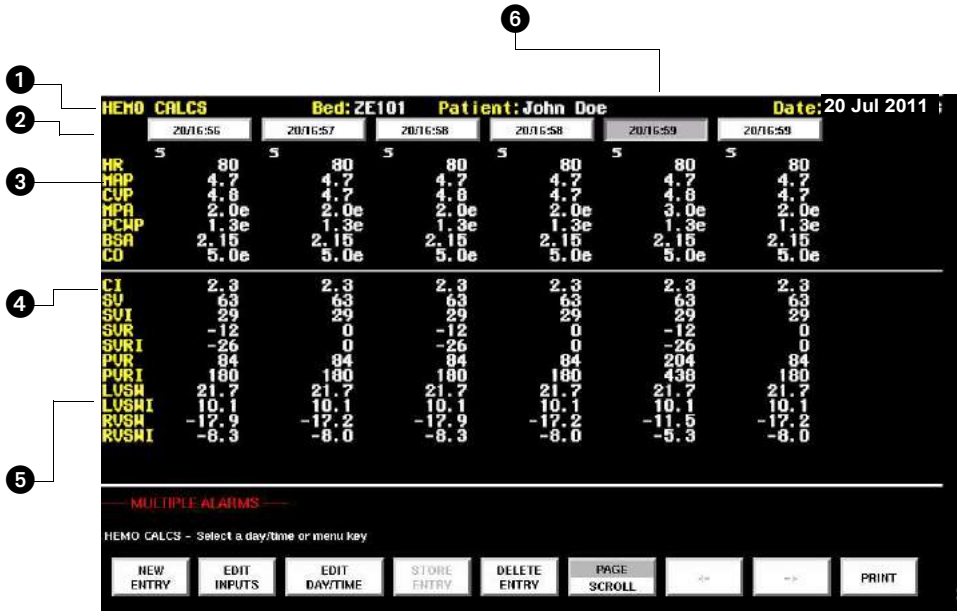



*Figure 27-1: Physiologic calculations table (Hemodynamics)*

1. The top line of the table shows the type of calculations performed, the bed name, patient name, and date.
2. A day/time key is displayed at the top of each data column. It indicates the day, hour, and minute of the data.
3. Calculation inputs
4. Dividing line
5. Calculated outputs
6. Selected record

***Note:***

*All keys appear disabled, except for NEW ENTRY and PRINT, until at least one record is displayed in the table.*

# Scrolling and Paging

Within the table, older records appear to the left and newer records appear to the right. Records created using NEW ENTRY appear to the right of the existing records. If the table is full, older records shift left one column so the new record can be displayed. Older records that are shifted off the display remain in memory and can be displayed by paging or scrolling.

Toggle the PAGE/SCROLL key to SCROLL, and use the arrow keys to move the Calculations table one column in the selected direction. Toggle the PAGE/SCROLL key to PAGE and use the arrow keys to move the table one page (seven columns) in the selected direction.

Touch the right arrow key to view the next newer column or page of data (the key is disabled when the newest record is displayed in the table). Touch the left arrow key to view the next older column or page of data (the key is disabled when the oldest record is displayed in the table).

**To view calculations data:**

- Touch CALCS.
- Select a calcs key.
- Toggle the PAGE/SCROLL key to SCROLL and use the ⇐ and ⇒ keys to move data by one column.

  -OR-
- Toggle the PAGE/SCROLL key to PAGE and use the ⇐ and ⇒ keys to move data by seven columns.

# Creating a New Entry

Touch the NEW ENTRY key to create a new record for the current day and time in the Calculations table, immediately to the right of existing records. The new record's day/time key is highlighted and contains the current day and time. Any available input values and calculated output values are displayed in this column. Any unavailable inputs or outputs are displayed as question marks.

NEW ENTRY is disabled when a total of 200 records exists in all the Physiologic calculations tables for the selected monitor. If you want to make further entries, you must first delete some of the existing entries from one or more of the calculations tables.

***Note:***

*After creating a NEW ENTRY, touch STORE ENTRY to store the entry in the database. Entries that have not been stored remain in the table until you select a different bed or patient; then they disappear.*

**To create a new entry/record:**

- Access Local or Remote Calcs.
- Touch CALCS.
- Select a Calcs key.
- Touch NEW ENTRY.
- Touch EDIT INPUTS to input new data not available in the system.
- Select an input key.
- Use the on-screen keypad to input the value.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU.
- Touch STORE ENTRY to retain entry in Calcs table.

# Editing Inputs

The **Edit Inputs** menu for each type of calculation contains keys for the inputs listed in the table. Each input's name and unit of measurement appear in these keys. Once an input has been edited, the letter **e** appears immediately after the edited value in the table.

***Note:***

- *The displayed units for pressure values, height, and weight may vary based on your monitor's configuration. Contact your system administrator for details.*
- *Changing the height and weight in the* **BSA** *menu does not affect the height and weight in the* **Admit/Discharge** *menu.*

When you select an input key, the on-screen keypad appears with that parameter label and value displayed at the top (refer to *Figure 27-2*). The value displayed is the selected item's current value from the table, if available. An input's default value appears if that value is unknown or if the value available from the system when that record was created/read is over or under the acceptable range.

Use the numeric digit keys to enter or edit the selected input value, or use the arrow keys to increase or decrease the value. Up to seven digits (including a decimal point and any undisplayed digits to its right), based on the assigned field size, can be entered at a time. You must touch the ENTER key on the keypad to save the edits and display the data in the calculations table.

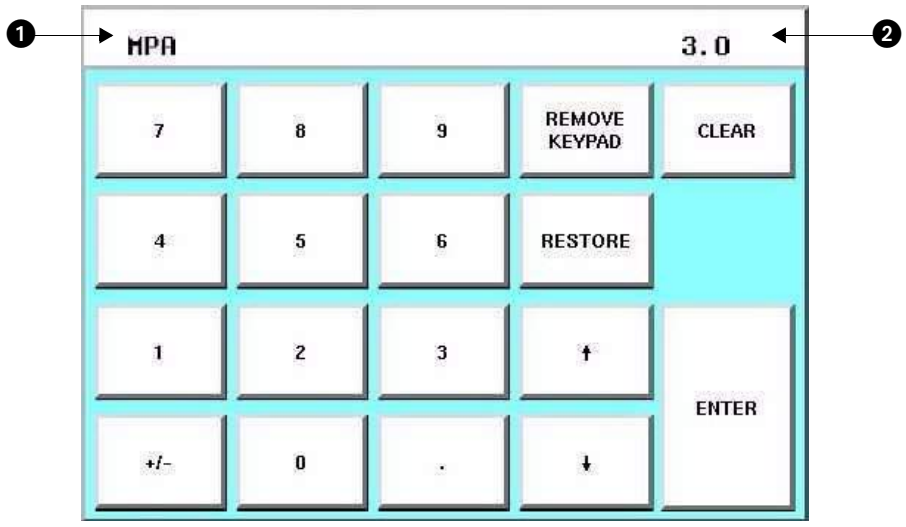



*Figure 27-2: On-screen keypad*

1. Input label
2. Input value

*Table 1* describes the use of the remaining keys on the keypad

*Table 1: Keypad Key Descriptions*

| Touch | Result |
|---|---|
| REMOVE KEYPAD | Closes the keypad and discards any changes made. |
| CLEAR | Sets the value displayed above the keypad to **0**. |
| RESTORE | Redisplays the value from the table above the keypad. |
| ± | Toggles the sign of the value displayed (disabled if the value cannot be negative). |
| ENTER | Saves the displayed value after verifying the input value is within its valid range:<br>• If the value is within its valid range, the keypad closes and the value is transferred to the table. Other values affected by this input value are recalculated and redisplayed, but not stored.<br>• If the value is outside its valid range, the monitor sounds a single error tone and displays an error message for 10 seconds. The entered input value remains above the keypad and can be cleared by touching RESTORE, CLEAR, or any number key. |

**To edit a record:**

- Access Local or Remote Calcs.
- Touch EDIT INPUTS.
- Select an input value to edit.
- Use the on-screen keypad to change the input value.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU then touch STORE ENTRY to retain the entry in the Calcs table.

If you enter a height and weight in the **BSA** menu, the system automatically computes a BSA. However, changing the BSA directly invalidates any height or weight previously entered. Refer to *Table 2* for BSA, height, and weight values for hemodynamics, oxygenation, and renal calculations.

*Table 2: BSA, Height, and Weight Calculations*

| Label | Name | Units | Valid Range |
|---|---|---|---|
| BSA | Body Surface Area | $m^2$ | 0.03 to 3.69 |
| HT | Height | cm<br>in | 20 to 215<br>7.9 to 84.6 |
| WT | Weight | kg<br>lb | 0.2 to 250.0<br>0.441 to 551.156 |
| $BSA = Ht^{0.725} \times Wt^{0.425} \times 0.007184$ | | | |

# Editing Day and Time

To create a calculations record for a specified day and time, create a new entry and highlight the day/time key at the top of the appropriate column. Touch EDIT DAY/TIME and enter the day and time for the record you want to create (you cannot change the value to a future time). Touch the DAY, HOUR, or MINUTE keys to highlight that key and display the on-screen keypad (refer to *Figure 27-2* on page 27-9). After you enter the day, hour, and minute, the input values and output calculations reflect data available from the system at the entered time. An **e** appears under any edited day/time key.

**To create a record for a past time:**

- Access Local or Remote Calcs.
- Touch NEW ENTRY.
- Highlight a day/time key on a new or prior entry.
- Touch EDIT DAY/TIME.
- Select DAY, HOURS, or MINUTES.
- Use the on-screen keypad to change.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU, then STORE ENTRY to retain the entry in the Calcs table.

Since the hour can appear in either 12-hour or 24-hour format, use the AM/PM key to select a.m. and p.m. on the DAY/TIME key if the system is set for 12-hour format.

# Storing and Deleting an Entry

After selecting a day/time key, you can store that record by touching STORE ENTRY, or you can delete that record by touching DELETE ENTRY. A menu appears to confirm the delete. Up to 100 stored records may be saved in each system. Deleting a record simultaneously deletes that record from the database if it was previously stored in the database via the STORE ENTRY key. Storing a record overwrites any data that was previously stored in the database for that record.

The letter **s** appears under the day/time key to indicate that the record is stored. If you edit a record after it is stored, the letter **s** is removed because the newly edited changes are not stored.

***Note:***

- *Stored records are saved until the monitor is powered OFF or until patient data is purged via the Admit/ Discharge function (refer to Discharging a Patient on page 8-7).*
- *Automatically displayed records, such as cardiac output data, remain in the database. These records reappear, even if deleted, when you leave and then return to a patient or bed.*
- *Records that are not stored will not be available on Remote Calcs or when Calcs is accessed again on the local monitor.*

**To store an entry:**

- Access Local or Remote Calcs.
- Highlight the day/time key of the entry to be stored.
- Touch STORE ENTRY.

**To delete an entry:**

- Access Local or Remote Calcs.
- Highlight the day/time key of the entry to be deleted.
- Touch DELETE ENTRY.
- Touch YES.

# Hemodynamic Calculations

Hemodynamic calculations provide data describing cardiovascular system performance. Cardiac output values from a Cardiac Output (CO) module automatically create records in the Hemodynamic Calculations table.

**To view current hemodynamic calculations:**

- Access Local or Remote Calcs.
- Touch HEMO CALCS.

When you create a new entry, the day/time key displays the current time and any current values for HR, MAP, CVP, MPA, PCWP, and body surface area are automatically displayed in the table. The most recent CO value (if less than 15 minutes old) is also put into the table. If the system locates a CO value, then values for MAP, CVP, MPA, or PCWP not currently available are put into the table from the CO record. Any inputs that remain unavailable appear as question marks. Refer to *Table 2* for BSA values.

*Table 3: Hemodynamic Inputs*

| Label | Name | Units | Default Value | Valid Range |
|---|---|---|---|---|
| HR | Heart Rate | bpm | 70 | 0 to 300 |
| MAP | Mean Arterial Pressure | mmHg<br>kPa | 80<br>10.7 | -50 to 300<br>6.7 to 40 |
| CVP | Central Venous Pressure | mmHg<br>kPa | 10<br>1.3 | -50 to 99<br>-6.7 to 15 |
| MPA | Mean Pulmonary Artery Pressure | mmHg<br>kPa | 15<br>2.0 | -50 to 99<br>-6.7 to 15 |
| PCWP | Pulmonary Capillary Wedge Pressure | mmHg<br>kPa | 10<br>1.3 | -50 to 99<br>-6.7 to 15 |
| CO | Cardiac Output | L/min | 5 | 0 to 40 |

Hemodynamic Calculations require specific pressure values, including CVP, MAP, and PCWP. CVP and MAP are monitored continuously; PCWP is an episodic value. A data substitution may occur if any of these pressure values are not available when you touch NEW ENTRY. When a substitution occurs, one of the following error messages appears on the message line.

- *Warning...RAP has been substituted for CVP.*

  A continuous RAP value is used instead of the continuous CVP value if CVP is not available.

- *Warning...NIBP has been substituted for MAP.*

  An episodic mean NIBP value that is less than 15 minutes old is used instead of MAP if the continuous MAP value is not available.

- *Warning...LAP has been substituted for PCWP.*

A continuous LAP value is used instead of the episodic PCWP value if the PCWP value is not available or is more than 15 minutes old.

*Table 4: Hemodynamic Outputs (assumes pressures are measured in mmHg)*

| Variable (Label) | Equations | Units | Normal Range |
|---|---|---|---|
| Cardiac Index (CI) | CO/BSA | L/min/$m^2$ | 2.5 to 4 |
| Stroke Volume (SV) | (CO/HR) × 1000 | ml/beat | 60 to 130 |
| Stroke Volume Index (SVI) | SV/BSA | ml/beat/$m^2$ | 30 to 65 |
| Systemic Vascular Resistance (SVR) | 79.9 × [(MAP – CVP)/CO] | dynes × sec/$cm^5$ | 900 to 1400 |
| Systemic Vascular Resistance Index (SVRI) | 79.9 × [(MAP – CVP)/CI]<br>79.9 × [(MAP – CVP)]/[CO/BSA]<br>79.9 × [(MAP – CVP)]/[CO × 1/BSA]<br>79.9 × [(MAP – CVP)/CO] × BSA<br>SVR × BSA | (dynes × sec/$cm^5$) × $m^2$ | 1760 to 2600 |
| Pulmonary Vascular Resistance (PVR) | 79.9 × [(MPA – PCWP)/CO] | dynes × sec/$cm^5$ | 20 to 130 |
| Pulmonary Vascular Resistance Index (PVRI) | 79.9 × [(MPA – PCWP)/CI]<br>79.9 × [(MPA – PCWP)]/[CO/BSA]<br>79.9 × [(MPA – PCWP)]/[CO × 1/BSA]<br>79.9 × [(MPA – PCWP)/CO] × BSA<br>PVR × BSA | (dynes × sec/$cm^5$) × $m^2$ | 36 to 235 |
| Left Ventricular Stroke Work (LVSW) | 0.0136 × SV × (MAP – PCWP) | g × min/beat | |
| Left Ventricular Stroke Work Index (LVSWI) | LVSW / BSA | g × min/beat/$m^2$ | 45 to 75 |
| Right Ventricular Stroke Work (RVSW) | 0.0136 × SV × (MPA – CVP) | g × min/beat | |
| Right Ventricular Stroke Work Index (RVSWI) | RVSW / BSA | g × min/beat/$m^2$ | 4 to 8 |
| Pressure values measured in kPa are automatically converted to mmHg prior to calculation. | | | |

# Respiration Calculations

Respiration calculations describe the performance of the lungs in the ventilation process. Most input values for respiration calculations must be manually entered, unless you have a ventilator Flexport system interface.

**To view respiration calculations:**

- Access Local or Remote Calcs.
- Touch RESP CALCS.

*Table 5: Respiration Inputs*

| Label | Name | Units | Default Value | Valid Range |
|---|---|---|---|---|
| RR | Respiration Rate | BPM | 20 | 0 to 200 |
| $PaCO_2$ | Partial Pressure of Arterial Carbon Dioxide | mmHg<br>kPa | 40<br>5.3 | 0 to 150<br>0 to 20 |
| VT | Tidal Volume | ml/breath | 500 | 0 to 3000 |
| PIP | Peak Inspiratory Pressure | $cmH_2O$ | 50 | 0 to 200 |
| PLT | Plateau Pressure | $cmH_2O$ | 30 | 0 to 200 |
| PEEP | Positive End Expiratory Pressure | $cmH_2O$ | 10 | 0 to 50 |
| $PECO_2$ | Partial Pressure of Expired Carbon Dioxide | mmHg<br>kPa | 35<br>4.7 | 0 to 150<br>0 to 20 |

*Table 6: Respiration Outputs*

| Variable (Label) | Equations | Units |
|---|---|---|
| Minute Volume (VMIN) | VT × RR/1000 | L/min |
| Static Compliance (Cst) | VT/(PLT – PEEP) | $ml/cmH_2O$ |
| Dynamic Compliance (Cdyn) | VT/(PIP – PEEP) | $ml/cmH_2O$ |
| Dead Space Volume (VD) | $(PaCO_2 – PECO_2) \times (VT/PaCO_2)$ | ml |
| Dead Space to Tidal Volume Ratio (VD/VT) | VD/VT | (ratio) |
| Alveolar Ventilation (VA) | (VT – VD) × RR | ml/min |

# Oxygenation Calculations

Oxygenation calculations provide specific data describing the efficiency with which the body acquires, circulates, and uses oxygen in the cardiopulmonary system. Input values for oxygenation calculations are automatically obtained from $SpO_2$, $SvO_2$, cardiac output modules, or Flexport interfaces. You must manually enter inputs for laboratory blood analysis values. Refer to *Table 2* and *Table 3* for BSA and CO values.

**To view oxygenation calculations:**

- Access Local or Remote Calcs.
- Touch OXY CALCS.

*Table 7: Oxygenation Inputs*

| Label | Name | Units | Default Value | Valid Range |
|---|---|---|---|---|
| $FiO_2$ | Fractional Inspired Oxygen | % | 50 | 0 to 100 |
| $PaO_2$ | Partial Pressure of Arterial Oxygen | mmHg<br>kPa | 100<br>13.3 | 0 to 500<br>0 to 70 |
| $SpO_2$ | Arterial Oxygen Saturation | % | 97 | 0 to 100 |
| $PaCO_2$ | Partial Pressure of Arterial Carbon Dioxide | mmHg<br>kPa | 40<br>5.3 | 0 to 150<br>0 to 20 |
| $PvO_2$ | Partial Pressure of Mixed Venous Oxygen | mmHg<br>kPa | 38<br>5.1 | 0 to 99<br>0 to 15 |
| $SvO_2$ | Mixed Venous Oxygen Saturation | % | 75 | 0 to 99 |
| Hgb | Hemoglobin | g/dl | 15 | 0 to 50.0 |
| PB | Barometric Pressure | mmHg<br>kPa | 760<br>101.3 | 0 to 1000<br>0 to 130 |

## Calculations

Calculating $O_2AV$, $O_2AVI$, $VO_2$, and $VO_2I$ requires a CO value to complete the calculations. The most recent CO value (less than 15 minutes old) is used for these calculations, if it is available.

*Table 8: Oxygenation Outputs*

| Variable (Label) | Equations | Units | Normal Range |
|---|---|---|---|
| Oxygen Availability ($O_2AV$) | $CTaO_2 \times CO \times 10$ | ml/min | 900 to 1100 |
| Oxygen Availability Index ($O_2AVI$) | $O_2AV/BSA$ | $ml/min/m^2$ | 497 to 608 |
| Arterial Oxygen Content ($CTaO_2$) | $(1.34 \times Hgb \times SpO_2/100) + (PaO2 \times 0.0031)$ | ml/dl | 18 to 20 |
| Mixed Venous Oxygen Content ($CTvO_2$) | $(1.34 \times Hgb \times SvO_2/100) + (PvO_2 \times 0.0031)$ | ml/dl | 14 to 16 |
| Arterial/Venous Oxygen Difference ($avDO_2$) | $CTaO_2 - CTvO_2$ | ml/dl | 3 to 5.5 |
| Oxygen Consumption ($VO_2$) | $avDO_2 \times CO \times 10$ | ml/min | 200 to 300 |
| Oxygen Consumption Index ($VO_2I$) | $VO_2/BSA$ | $ml/min/m^2$ | 110 to 166 |
| Oxygen Extraction Ratio ($O_2ER$) | $VO_2/O_2AV$ (Simplifies to $avDO_2/CTaO_2$) | (ratio) | 1/4 or 0.25 |
| Partial Pressure of Alveolar Oxygen ($PAO_2$) | $[(FiO_2/100) \times (PB - 47)] - PaCO_2/0.8$ | mmHg | 100 |
| Pulmonary Venous Admixture Shunt (Qs/Qt) | $\frac{100 \times [(1.34 \times Hgb) + (0.0031 \times PAO_2) - CTaO_2]}{(1.34 \times Hgb) + (0.0031 \times PAO_2) - CTvO_2}$ | % | Variable, depending on $FiO_2$ |
| $PaO_2/FiO_2$ Ratio (P/F) | $PaO_2/(FiO_2/100)$ | mmHg or kPa | Variable, depending on $FiO_2$ |

# Renal Calculations

Renal calculations provide data related to kidney function. Input for renal calculations, other than a previously entered BSA, must be manually entered and may be derived from laboratory measurements. The system automatically computes BSA when you enter a height and weight into this menu. Refer to *Table 2* for BSA values.

**To view current renal calculations:**

- Access Local or Remote Calcs.
- Touch RENAL CALCS.

*Table 9: Renal Inputs*

| Label | Name | Units | Default Value | Valid Range |
|---|---|---|---|---|
| URK | Urine Potassium | mEq/L | 60 | 0 to 300 |
| PLOSM | Plasma Osmolality | mOsm/L | 290 | 0 to 999 |
| UROSM | Urine Osmolality | mOsm/L | 575 | 0 to 9999 |
| SerNa | Serum Sodium | mEq/L | 140 | 0 to 999 |
| CR | Serum Creatinine | mg/dl | 1.10 | 0 to 9.99 |
| UCR | Urine Creatinine | mg/dl | 50.0 | 0 to 999.9 |
| BUN | Blood Urea Nitrogen | mg/dl | 12 | 0 to 999 |
| URNa | Urine Sodium | mEq/L | 90 | 0 to 999 |
| URINE | Urine Volume | ml/day | 2000 | 0 to 9999 |

*Table 10: Renal Outputs*

| Variable (Label) | Equations | Units |
|---|---|---|
| Urine Sodium Excretion (URNaEX) | URNa × URINE/1000 | mEq/day |
| Urine Potassium Excretion (URKEX) | URK × URINE/1000 | mEq/day |
| Urine Sodium to Urine Potassium Ratio (Na/K) | URNa/URK | (ratio) |
| Osmolar Clearance (COSM) | (UROSM/PLOSM) × URINE | ml/day |
| Water Clearance ($CH_2O$) | URINE – COSM | ml/day |

*Table 10: Renal Outputs (continued)*

| Variable (Label) | Equations | Units |
|---|---|---|
| Urine Osmolality to Plasma Osmolality Ratio (U/POSM) | UROSM/PLOSM | (ratio) |
| Fractional Sodium Excretion (FENa) | (URNa/SerNa) × (CR/UCR) × 100 | % |
| Creatinine Clearance (CRCL) | (UCR/CR) × URINE/1440) × 1.73/BSA | ml/min/$m^2$ |
| Non-Saline Loss (NSLOSS) | URINE – (URINE × URNa/SerNa) | ml/day |
| BUN to Creatinine Ratio (BUN/CR) | BUN/CR | (ratio) |
| Urine Creatinine to Serum Creatinine Ratio (U/CR) | UCR/CR | (ratio) |

# Setting Up Drug Dosage Calculations

The Drug Dosage calculation feature enables you to edit the inputs and store up to six drug records.

**Caution:**

**Use caution when entering drug dosage values manually. Ensure that any changes you initiate are appropriate for the age and condition of the patient before you touch ENTER on the on-screen keypad.**

**From the Drug Dosage menu, you can:**

- Edit the inputs
  (refer to *Editing Inputs and Changing Units of Measurement* on page 27-23)
- Store up to six drug records
  (refer to *Storing a Record* on page 27-24)
- Display two titration tables for each of these drug records
  (refer to *Displaying Titration Tables* on page 27-25)
- Print any of the displayed information
  (refer to *Printing Calculations Data* on page 27-26)

**To access drug dosage calcs:**

- Touch SPECIAL FUNCTIONS.
- Touch LOCAL TRENDS/CALCS or REMOTE TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, then select a bed.
- Touch DRUG CALCS.

**To enter a drug dose value:**

- Access Local or Remote Drug Calcs as described above.
- Select DRUG A, B, C, D, E, or F.
- Touch EDIT INPUTS.
- Select the desired input key.
- Use the on-screen keypad to change the value.
- Touch ENTER on the on-screen keypad.

**Drug dosage calculations operate similarly to physiologic calculations, except for the following differences:**

- Weight is handled differently. When you begin drug dosage calculations, the patient's currently stored weight (automatically converted to kilograms) appears in the table. Weight must be entered in kilograms. While WEIGHT is the only drug dosage input automatically entered by the system, default values are present when you first display the table. You can edit any value by manually entering a new value.
- Patient type is controlled by the setting made in the **Patient Demograpics** dialog box.

# Display Detail — Drug Dosage Calculations

When you touch DRUG CALCS, either the Adult display or the Neonatal Drug Calcs display displays, along with the **Drug Dosage** menu keys (refer to *Figure 27-4* through *Figure 27-6)*. The Drug Dosage calculations table has a different format than the physiologic calculations table, but occupies the same four lower display zones.

***Note:***

*Because only three columns appear on the display at one time, each illustration includes two displays — one with columns for Drug A, B, and C, and one with columns for Drug D, E, and F.*


1
2
3
ADULT DRUG CALCS Bed:SL001 Patient: Date: 20 Jul 2011
DRUG A
DRUG B
DRUG C
NAME
AMOUNT 400.00 mg 2.00 g 16.00 mg
VOLUME 250 ml 250 ml 250 ml
CONC 1.60 mg/ml 8.00 mg/ml 64.00 mcg/ml
WEIGHT 70.000 kg 70.000 kg 70.000 kg
DOSE 500.00 mcg/min 2.00 mg/min 10.00 mcg/min
30.00 mg/hr 120.00 mg/hr 600.00 mcg/hr
7.14 mcg/kg/min 28.57 mcg/kg/min 0.14 mcg/kg/min
428.57 mcg/kg/hr 1.71 mg/kg/hr 8.57 mcg/kg/hr
RATE 18.75 ml/hr 15.00 ml/hr 9.38 ml/hr
DURATION 1.00 hr 1.00 hr 1.00 hr
TOTAL DOSE 30.00 mg 120.00 mg 600.00 mcg
TOTAL VOL 18.75 ml 15.00 ml 9.38 ml
Local printer paper out.
ADULT DRUG DOSAGE - Select a drug or menu key.
EDIT INPUTS
STORE ENTRY
TITRATION TABLE
<=
=>
PRINT
UPDATE DATA

*Figure 27-3: Adult drug calculations (drug keys A through C)*


1
2
3
ADULT DRUG CALCS Bed:SL001 Patient: Date: 20 Jul 2011
DRUG D
DRUG E
DRUG F
NAME
AMOUNT 50.00 mg 50.00 mg 50.00 mg
VOLUME 250 ml 250 ml 250 ml
CONC 200.00 mcg/ml 200.00 mcg/ml 200.00 mcg/ml
WEIGHT 70.000 kg 70.000 kg 70.000 kg
DOSE 200.00 mcg/min 200.00 mcg/min 200.00 mcg/min
12.00 mg/hr 12.00 mg/hr 12.00 mg/hr
2.86 mcg/kg/min 2.86 mcg/kg/min 2.86 mcg/kg/min
171.43 mcg/kg/hr 171.43 mcg/kg/hr 171.43 mcg/kg/hr
RATE 60.00 ml/hr 60.00 ml/hr 60.00 ml/hr
DURATION 1.00 hr 1.00 hr 1.00 hr
TOTAL DOSE 12.00 mg 12.00 mg 12.00 mg
TOTAL VOL 60.00 ml 60.00 ml 60.00 ml
--- ALARM VIOLATION ---
ADULT DRUG DOSAGE - Select a drug or menu key.
EDIT INPUTS
STORE ENTRY
TITRATION TABLE
<=
=>
PRINT
UPDATE DATA

*Figure 27-4: Adult drug calculations (drug keys D through F)*


1
2
3
4
NEONATAL DRUG CALCS Bed:SL001 Patient: Date: 20 Jul 2011
DRUG A MIX
DRUG B MIX
DRUG C MIX
NAME
AMOUNT 10.00 mg 1.00 mg 2.50 g
VOLUME 100 ml 100 ml 100 ml
CONC 100.00 mcg/ml 10.00 mcg/ml 25.00 mg/ml
WEIGHT 1.500 kg 1.500 kg 1.500 kg
DOSE 7.50 mcg/min 0.75 mcg/min 83.33 mcg/min
450.00 mcg/hr 45.00 mcg/hr 5.00 mg/hr
5.00 mcg/kg/min 0.50 mcg/kg/min 55.56 mcg/kg/min
300.00 mcg/kg/hr 30.00 mcg/kg/hr 3.33 mg/kg/hr
RATE 4.50 ml/hr 4.50 ml/hr 0.20 ml/hr
DURATION 1.00 hr 1.00 hr 1.00 hr
TOTAL DOSE 450.00 mcg 45.00 mcg 5.00 mg
TOTAL VOL 4.50 ml 4.50 ml 0.20 ml
Local printer paper out.
NEONATAL DRUG DOSAGE - Select a drug or menu key.
EDIT INPUTS
STORE ENTRY
TITRATION TABLE
MIX TITRATE
<=
=>
PRINT
UPDATE DATA

*Figure 27-5: Neonatal drug calculations (drug keys A through C)*


1
2
3
4
NEONATAL DRUG CALCS Bed:SL001 Patient: Date: 20 Jul 2011
DRUG D MIX
DRUG E MIX
DRUG F MIX
NAME
AMOUNT 3.00 mg 3.00 mg 3.00 mg
VOLUME 100 ml 100 ml 100 ml
CONC 30.00 mcg/ml 30.00 mcg/ml 30.00 mcg/ml
WEIGHT 1.500 kg 1.500 kg 1.500 kg
DOSE 0.75 mcg/min 0.75 mcg/min 0.75 mcg/min
45.00 mcg/hr 45.00 mcg/hr 45.00 mcg/hr
0.50 mcg/kg/min 0.50 mcg/kg/min 0.50 mcg/kg/min
30.00 mcg/kg/hr 30.00 mcg/kg/hr 30.00 mcg/kg/hr
RATE 1.50 ml/hr 1.50 ml/hr 1.50 ml/hr
DURATION 1.00 hr 1.00 hr 1.00 hr
TOTAL DOSE 45.00 mcg 45.00 mcg 45.00 mcg
TOTAL VOL 1.50 ml 1.50 ml 1.50 ml
Local printer paper out.
NEONATAL DRUG DOSAGE - Select a drug or menu key.
EDIT INPUTS
STORE ENTRY
TITRATION TABLE
MIX TITRATE
<=
=>
PRINT
UPDATE DATA

*Figure 27-6: Neonatal drug calculations (drug keys D through F)*

1. Identifies adult or neonatal drug calculations, the bed name, patient name, and date
2. Selected DRUG key

❸ Drug Calculations data

❹ MIX/TITRATE key (neonatal only)

Select the DRUG A through F keys as you selected the day/time keys in the physiologic calculations tables. Selecting a drug key enables you to edit the data in the column below it.

You can enter drug values for adults or neonates, depending on the current patient type selection (refer to *Changing or Entering New Patient Data on page 8-3* for more information). If NEONATE was selected, the MIX/TITRATE key displays. The MIX/TITRATE key toggles to highlight either MIX or TITRATE, and affects how calculations are performed when the DOSE is edited. Each column's default values are derived from common mixtures of frequently used drugs.

# Editing Inputs and Changing Units of Measurement

To begin editing input values, touch the DRUG key. Touch EDIT INPUTS to display the **Edit Inputs Menu**.




*Figure 27-7: Edit Inputs Menu*

Touching any input key on the **Edit Inputs Menu**, except DRUG, UNITS, or DOSE (described below), displays the on-screen keypad. During editing, the menu prompt shows the minimum and maximum values you can enter. Touch ENTER on the on-screen keypad to update the Drug Dosage table.

*Table 11: Drug Dosage Calculations*

| Label | Valid Range | Possible Units of Measurement |
|---|---|---|
| AMOUNT | 0.01 to 9999.99 | mcg, mg, g, mEq, units, k units, m units |
| VOLUME | 1 to 9999 | ml |
| CONC | 0.01 to 9999.99 | mcg/ml, mg/ml, g/ml, mEq/ml, units/ml, k units/ml, m units/ml |
| WEIGHT | 0.2 to 250 | kg |
| DOSE/MIN & DOSE/HR | 0.01 to 9999.99 | * mcg/xx, mg/xx, g/xx, mEq/xx, units/xx, k units/xx, m units/xx |
| DOSE/WT/MIN & DOSE/WT/HR | 0.01 to 9999.99 | * mcg/kg/xx, mg/kg/xx, g/kg/xx, mEq/kg/xx, units/kg/xx, k units/kg/xx, m units/kg/xx |
| RATE | 0.1 to 999.99 | ml/hr |
| DURATION | 0.1 to 999.99 | hr |
| TOTAL DOSE | 0.01 to 9999.9 | mcg, mg, g, mEq, units, k units, m units |
| TOTAL VOL | 0.1 to 9999.99 | ml |
| * xx = minutes or hours | | |

Units of measurement are displayed to the right of the data values in the table. The **Select units** menu enables you to choose one of three types of units (grams, mEq, and units) for AMOUNT or DOSE. Changing the unit type for AMOUNT changes the unit type for DOSE. Changing the selected units for AMOUNT may also change the displayed units for CONCENTRATION (CONC). Changing the selected units for DOSE may also change the displayed units for DOSE/WT and TOTAL DOSE.

**To change drug units:**

- Access Local or Remote Drug Calcs.
- Select a Drug key.
- Touch EDIT INPUTS.
- Touch UNITS.
- Select the units to change.

Editing either AMOUNT or DOSE may scale the values and units for CONC, DOSE, DOSE/WT, and TOTAL DOSE up or down for values less than 0.01 or greater than 9999.99.

If the values for CONC, DOSE/HR, DOSE/WT/HR, and TOTAL DOSE exceed the range of their currently selected units, that value is divided by 1000 and the units change accordingly. For example, if the value for TOTAL DOSE is 123,456 mg, it will appear as 123.46 g. This value is rounded because only two digits can be displayed to the right of the decimal point.

Changing the units for DOSE may change the units for DOSE/WT and TOTAL DOSE. As a result, both the minute and hour values for DOSE and DOSE/WT may change.

When you select DOSE in the **Edit Inputs** menu, four dose type keys are displayed. Select any of these keys to edit the corresponding value shown in the Drug Dosage Calculations table. The system automatically calculates and displays the changes for the other three dose types in the Drug Dosage Calculations table.

The dose type selected for a specific drug defines the dose unit used for that drug's titration tables.

# Storing a Record

Touch STORE ENTRY to store the record, and the letter **s** then appears under the associated DRUG key. You can store up to six records, one for each DRUG key. If you edit a record that has been stored, the system removes the letter **s**, because the newly edited changes have not yet been stored.

**To store a drug record entry:**

- Access Local or Remote Drug Calcs.
- Select a Drug key.
- Touch STORE ENTRY.

# Displaying Titration Tables

The VARY RATE/DOSE toggle key and DOSE TYPE keys are displayed when you touch TITRATION TABLE. VARY RATE varies the rate (holding the concentration constant) and calculates (titrates) the corresponding dose using the selected dose unit type. VARY DOSE varies the dose (holding the drug concentration constant) and titrates the corresponding delivery rate in ml/hr.

**To display titration tables:**

- Access Local or Remote Drug Calcs.
- Touch TITRATION TABLE.

**To vary based on rate/dose:**

- Access Local or Remote Drug Calcs.
- Touch TITRATION TABLE.
- Touch VARY RATE/DOSE.

Touch the DOSE TYPE key while VARY / DOSE is selected to display the **Dose Type** menu. Selecting a key from this menu updates the Titration table to reflect the selected dose type.

In the titration tables, flow rate and dose are calculated using the equations below. Dosages can vary between 0.01 and 9999.99 mg/min, and rates can vary between 0.1 and 999.99 ml/hr.

$$\text{RATE in ml/hr} = \frac{\text{DOSE} \times 60 \text{ minutes}/1 \text{ hour}}{\text{AMOUNT/VOLUME}}$$

$$\text{DOSE in xx/min} = \frac{\text{FLOW RATE} \times \text{AMOUNT} \times 1\text{hour}/60 \text{ minutes}}{\text{VOLUME}}$$

*Figure 27-8* shows a sample Vary Rate Titration table. The patient type (ADULT or NEONATE) appears at the top of the table. The amount and volume appear below the patient type, along with the dose and rate units. The units for amount and dose are the same units used in the Drug Dosage table.

The drug (A through F) and patient weight appear in the upper right portion of the table.



NEONATAL DRUG CALCS Bed: ZE101 Patient: John Doe Date: 20 Jul 2011

AMOUNT = 10.00 mg DOSE = 7.50 mcg/min DRUG A

VOLUME = 100 ml RATE = 4.50 ml/hr WEIGHT = 1.500 kg

| Dose | Rate | Dose | Rate | Dose | Rate | Dose | Rate | Dose | Rate |
|---|---|---|---|---|---|---|---|---|---|
| 7.33 | 4.40 | 10.67 | 6.40 | 14.00 | 8.40 | 17.33 | 10.40 | 20.67 | 12.40 |
| 7.50 | 4.50 | 10.83 | 6.50 | 14.17 | 8.50 | 17.50 | 10.50 | 20.83 | 12.50 |
| 7.67 | 4.60 | 11.00 | 6.60 | 14.33 | 8.60 | 17.67 | 10.60 | 21.00 | 12.60 |
| 7.83 | 4.70 | 11.17 | 6.70 | 14.50 | 8.70 | 17.83 | 10.70 | 21.17 | 12.70 |
| 8.00 | 4.80 | 11.33 | 6.80 | 14.67 | 8.80 | 18.00 | 10.80 | 21.33 | 12.80 |
| 8.17 | 4.90 | 11.50 | 6.90 | 14.83 | 8.90 | 18.17 | 10.90 | 21.50 | 12.90 |
| 8.33 | 5.00 | 11.67 | 7.00 | 15.00 | 9.00 | 18.33 | 11.00 | 21.67 | 13.00 |
| 8.50 | 5.10 | 11.83 | 7.10 | 15.17 | 9.10 | 18.50 | 11.10 | 21.83 | 13.10 |
| 8.67 | 5.20 | 12.00 | 7.20 | 15.33 | 9.20 | 18.67 | 11.20 | 22.00 | 13.20 |
| 8.83 | 5.30 | 12.17 | 7.30 | 15.50 | 9.30 | 18.83 | 11.30 | 22.17 | 13.30 |
| 9.00 | 5.40 | 12.33 | 7.40 | 15.67 | 9.40 | 19.00 | 11.40 | 22.33 | 13.40 |
| 9.17 | 5.50 | 12.50 | 7.50 | 15.83 | 9.50 | 19.17 | 11.50 | 22.50 | 13.50 |
| 9.33 | 5.60 | 12.67 | 7.60 | 16.00 | 9.60 | 19.33 | 11.60 | 22.67 | 13.60 |
| 9.50 | 5.70 | 12.83 | 7.70 | 16.17 | 9.70 | 19.50 | 11.70 | 22.83 | 13.70 |
| 9.67 | 5.80 | 13.00 | 7.80 | 16.33 | 9.80 | 19.67 | 11.80 | 23.00 | 13.80 |
| 9.83 | 5.90 | 13.17 | 7.90 | 16.50 | 9.90 | 19.83 | 11.90 | 23.17 | 13.90 |
| 10.00 | 6.00 | 13.33 | 8.00 | 16.67 | 10.00 | 20.00 | 12.00 | 23.33 | 14.00 |
| 10.17 | 6.10 | 13.50 | 8.10 | 16.83 | 10.10 | 20.17 | 12.10 | 23.50 | 14.10 |
| 10.33 | 6.20 | 13.67 | 8.20 | 17.00 | 10.20 | 20.33 | 12.20 | 23.67 | 14.20 |
| 10.50 | 6.30 | 13.83 | 8.30 | 17.17 | 10.30 | 20.50 | 12.30 | 23.83 | 14.30 |

*Figure 27-8: Titration table*

Use the SCROLL and PAGE keys in the **Titration Table** menu to select the range of data displayed in the titration table. The default range is 1 to 100.

***Note:***

*If any value in the Drug Calculation table is over its designated range, then ++++.++ appear for values of AMOUNT, CONC, DOSE, or RATE, and the TITRATION TABLE key becomes inaccessible.*

# Printing Calculations Data

Touch the PRINT key to print the current page of the Calculations table. When using a two-channel printer, the top and bottom halves of the table print consecutively.

**To print calcs data:**

- Access Local or Remote Drug Calcs.
- Touch PRINT.

# Recalculations

*Table 12: Drug Dosage Equations*

| | | |
|---|---|---|
| CONC | = | Amount/Volume |
| TOTAL VOL | = | Rate × Duration |
| TOTAL DOSE | = | Dose × Duration |

You can recalculate all Drug Dosage inputs except for the amount/hour entries shown for DOSE and DOSE/WT. In most cases, changing one parameter automatically recalculates and redisplays other parameters under that DRUG key. *Table 13* shows adult patient recalculation rules, except where noted in AMOUNT and VOLUME. When TITRATE on the MIX/TITRATE key is selected, DOSE, DOSE/WEIGHT, and FLOW RATE results are the same for adult and neonatal.

*Table 13: Recalculation Rules*

| Edit | Constants | Results |
|---|---|---|
| AMOUNT (adult) | Holds VOLUME constant<br>Holds DOSE constant<br>Holds DUR constant | Calculates CONC<br>Calculates RATE<br>Calculates TOTAL VOL |
| AMOUNT (neonatal) | Holds VOLUME constant<br>Holds DUR constant | Calculates CONC<br>Calculates DOSE and TOTAL DOSE |
| VOLUME (adult) | Holds AMOUNT constant<br>Holds DOSE/MIN constant<br>Holds DUR constant<br>Holds TOTAL DOSE constant | Calculates CONC<br>Calculates RATE<br>Calculates TOTAL VOL |
| VOLUME (neonatal) | Holds AMOUNT constant<br>Holds RATE constant<br>Holds DUR constant<br>Holds TOTAL VOL constant | Calculates CONC<br>Calculates DOSE<br>Calculates TOTAL DOSE |
| CONC | Holds VOLUME constant<br>Holds DOSE/MIN constant<br>Holds DUR constant | Calculates AMOUNT<br>Calculates RATE<br>Calculates TOTAL VOL |

*Table 13: Recalculation Rules (continued)*

| Edit | Constants | Results |
|---|---|---|
| WEIGHT | Holds DOSE/MIN constant<br>Holds DOSE/HR constant | Calculates DOSE/WEIGHT/MIN<br>Calculates DOSE/WEIGHT/HR |
| DOSE or DOSE/WEIGHT (TITRATE) | Holds WEIGHT constant<br>Holds CONC constant<br>Holds DUR constant | Calculates other three DOSE and DOSE/WEIGHTS<br>Calculates RATE<br>Calculates TOTAL DOSE and TOTAL VOL |
| DOSE or DOSE/WEIGHT (MIX) | Holds WEIGHT constant<br>Holds RATE constant<br>Holds VOLUME constant<br>Holds DUR constant | Calculates other three DOSE and DOSE/WEIGHTS<br>Calculates CONC<br>Calculates AMOUNT<br>Calculates TOTAL DOSE |
| RATE (TITRATE) | Holds CONC constant<br>Holds WEIGHT constant<br>Holds DUR constant | Calculates DOSE/MIN and DOSE/HR<br>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR<br>Calculates TOTAL VOL and TOTAL DOSE |
| RATE (MIX) | Holds DOSE/HR constant<br>Holds VOLUME constant<br>Holds DUR constant | Calculates CONC<br>Calculates AMOUNT<br>Calculates TOTAL VOL |
| DUR | Holds DOSE/MIN constant<br>Holds RATE constant | Calculates TOTAL DOSE<br>Calculates TOTAL VOL |
| TOTAL DOSE | Holds CONC constant<br>Holds DUR constant<br>Holds WEIGHT constant | Calculates RATE<br>Calculates DOSE/MIN, DOSE/HR, and TOTAL VOL<br>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR |
| TOTAL VOL | Holds DUR constant<br>Holds CONC constant<br>Holds WEIGHT constant | Calculates RATE<br>Calculates DOSE/MIN and DOSE/HR<br>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR<br>Calculates TOTAL DOSE |

# Configurable Drug Names

## Using the Drug Name List

**To use the list of drug names:**

1 Touch the DRUG key in the Drug Calcs **Edit Inputs** menu to display the **Drug Name List**.

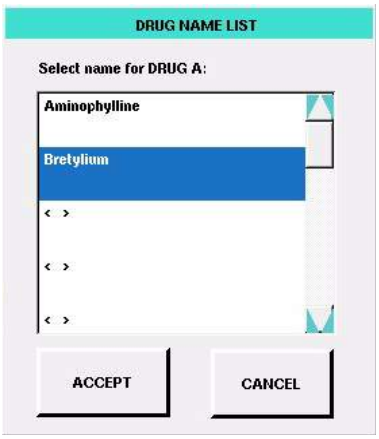



*Figure 27-9: Drug Name List*

2 Select a drug name from the list and touch ACCEPT to transfer the drug name along with its stored default values to the currently selected drug key (A through F). (Touching CANCEL closes the **Drug Name List**.) Drug Calcs will display the selected drug name below the key (refer to *Figure 27-10*).

ADULT DRUG CALCS Bed: ICU06 Patient: DOE, JOHN J Date: 20 Jul 2011

| | DRUG A | | DRUG B | | DRUG C | |
|---|---|---|---|---|---|---|
| NAME | Dopamine | | | | | |
| AMOUNT | 400.00 | mg | 2.00 | g | 16.00 | mg |
| VOLUME | 250 | ml | 250 | ml | 250 | ml |
| CONC | 1.60 | mg/ml | 8.00 | mg/ml | 64.00 | mcg/ml |
| WEIGHT | 70.000 | kg | 70.000 | kg | 70.000 | kg |
| DOSE | 500.00 | mcg/min | 2.00 | mg/min | 10.00 | mcg/min |
| | 30.00 | mg/hr | 120.00 | mg/hr | 600.00 | mcg/hr |
| | 7.14 | mcg/kg/min | 28.57 | mcg/kg/min | 0.14 | mcg/kg/min |
| | 428.57 | mcg/kg/hr | 1.71 | mg/kg/hr | 8.57 | mcg/kg/hr |
| RATE | 18.75 | ml/hr | 15.00 | ml/hr | 9.38 | ml/hr |
| DURATION | 1.00 | hr | 1.00 | hr | 1.00 | hr |
| TOTAL DOSE | 30.00 | mg | 120.00 | mg | 600.00 | mcg |
| TOTAL VOL | 18.75 | ml | 15.00 | ml | 9.38 | ml |

*Figure 27-10: Drug Calcs display*

***Note:***

*The drug default values for drugs A through F can be overwritten and not affect the master drug list entry. However, selecting another drug name for drug A, B, C, D, E, or F overrides all previously edited values and inserts the master default settings. Ensure that the changes are implemented after selecting the drug name (and not before).*

# Trends

## Directory of Keys

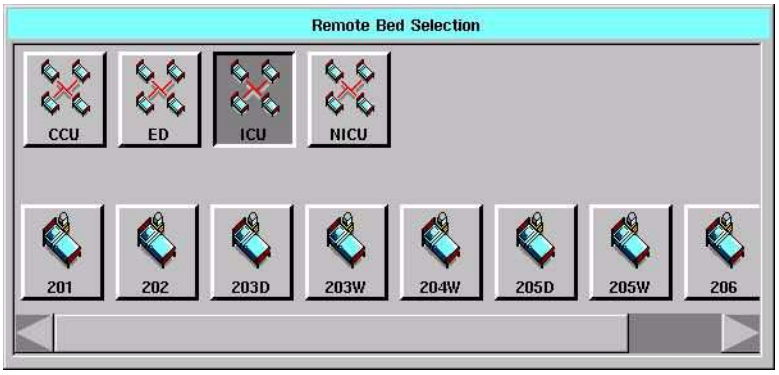
### Remote and Tabular Trends




*Refer to Introduction* | | | *Refer to Alarms* | *Refer to Printing* | *Refer to Introduction*

**SPECIAL FUNCTIONS**

LOCAL TRENDS/ CALCS | REMOTE TRENDS/CALCS




**TRENDS/CALCS for BED xxx**

GRAPHIC TRENDS | TABULAR TRENDS

*Refer to page 28-2*

**TABULAR TRENDS**

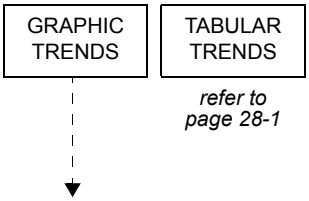
TIME INTERVAL | PAGE / SCROLL | ↑ | ↓ | ← | → | PRINT | GRAPHIC TRENDS

**CHANGE TIME INTERVAL**

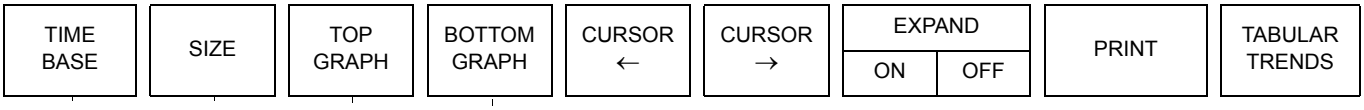
1 MIN | 5 MIN | 10 MIN | 15 MIN | 30 MIN | 1 HR | 1.5 HR | 3 HR

# Graphic Trends

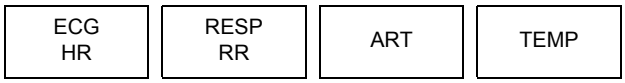
### TRENDS/CALCS for BED xxx




### GRAPHIC TRENDS

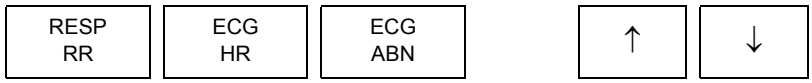



### TREND PARAMETERS



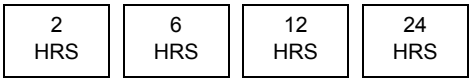

***Note:*** *The number of keys and their labels will vary according to parameters currently being trended.*

### CHANGE SIZE




***Note:*** *The number of keys and their labels will vary according to parameters currently being trended.*

### CHANGE TIME BASE



# Trends

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Graphic and Tabular Trend Settings . . . . . 7
Trends Troubleshooting Guide . . . . . 9

## Overview

Trends display numeric data collected for a patient over a 24-hour period in either a graphical or tabular format (similar to a common flowsheet or spreadsheet). Up to the last 24 hours of collected data are available, for as long as memory limitations allow. Data older than 24 hours do not display.

The monitor collects trend values every minute and collects episodic trend values as they become available, for all parameters except delta temperature and EEG. The monitor maintains settings for trend displays (time base, parameters, size, etc.) until you change them or until you view a new patient's trend.

**To view a trend:**

- Touch SPECIAL FUNCTIONS.
- Select LOCAL TRENDS/CALCS or REMOTE TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, select a bed.
- Select GRAPHIC TRENDS or TABULAR TRENDS.

**(Follow these steps to start each Quickstart in this chapter.)**

***Note:***

- *When you suspend alarms with the ALARM SUSPEND key, the monitor may not collect trend data. Contact your system administrator to enable this function.*
- *Trends does not display data resulting from calculations.*
- *The message No trends available* for this bed *or* Trend data not available *appears if data have not yet been accumulated for the selected bed.*
- *Trend data are not collected while ECG or $SpO_2$ processing is suspended.*

# Display Detail

## Graphic Trends

**Graphic trends can appear in three formats:**

- Continuous trends — Represent parameters with continuous monitoring. A solid line connects trend points.
- Episodic trends — Represent parameters that produce individual events. Episodic values appear as an **x**, **+**, or **0**. A dotted line connects each episode. In most cases, an episodic trend contains at least 30 values.
- Histogram trends — Display as vertical bars starting at a base of zero.

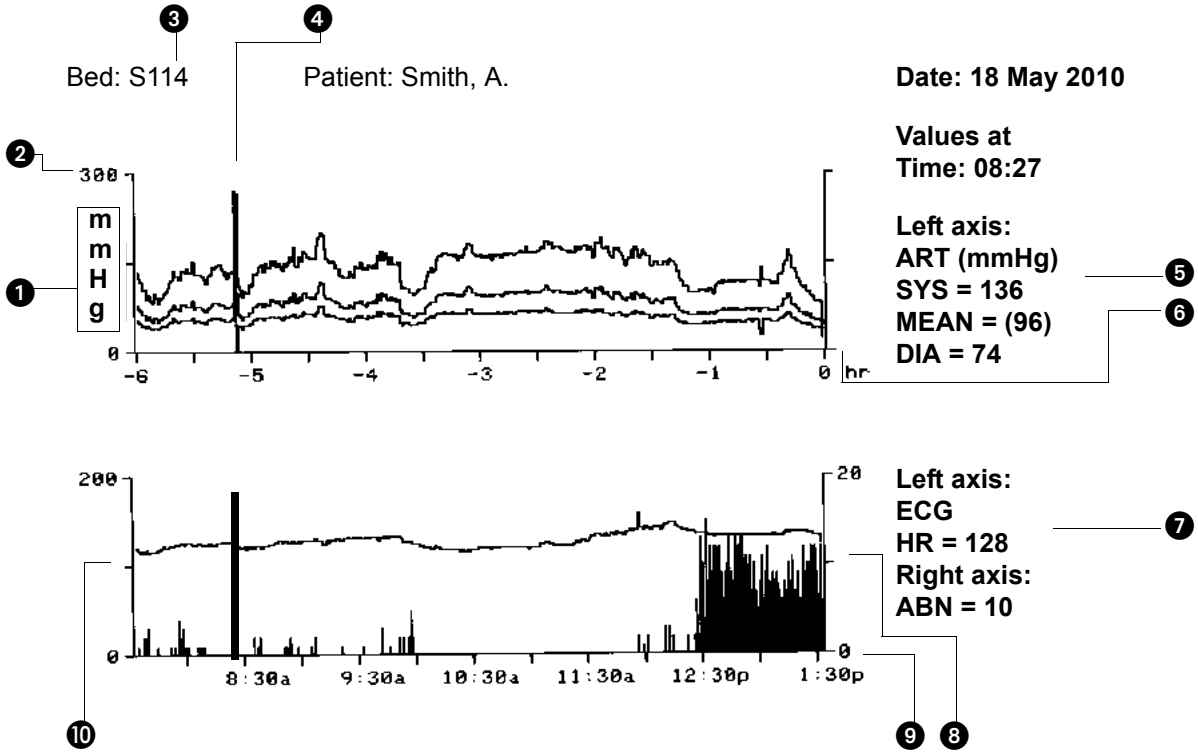



*Figure 28-1: Graphic trend display*

1. Trend unit of measurement (unit labels do not display for parameters with one acknowledged unit of measurement, for example, ECG, RESP, and CO)
2. Scale value — use the SIZE key to select
3. Bed/patient ID
4. Cursor
5. Data values for top graph at the selected time
6. Upper trend graph time axis
7. Data values for bottom graph

❽ Right axis for bottom graph

❾ Lower trend graph time axis at the selected time

❿ Left axis for bottom graph

The graphic trend cursor is a solid, vertical line that moves across the entire trend graph (refer to ❹ in *Figure 28-1*). The home position of the cursor is at the extreme right end of the graph. When the cursor is at its home position, data values reflect current values and the **Current Values** label is displayed. Once the cursor moves from its home position, the values change to reflect data acquired from the patient at that cursor location time, and the **Values at** label and time are displayed.

***Note:***

- *The trend graph continues to update, EXCEPT when the cursor is moved from its home position. It updates again when the cursor returns to its home position.*
- *When switching between graphic trends and tabular trends, the cursor maintains the same relative position.*

**To move the cursor, touch the cursor keys as needed.**

## Tabular Trends

You can view a tabular trend of continuous patient data and episodic patient data by touching the TABULAR TRENDS key. Data older than 24 hours do not display. Parameters always appear in descending order of priority. Data acquired on a continuous basis always precede episodic data. Episodic values are presented according to the sequence in which they were originally stored.

The tabular trend table displays up to 22 rows and 7 columns of parameter data on a single display. You can view additional parameters by scrolling or paging up or down. You can view data collected at other times by scrolling or paging left or right.

| ❶ | | ❷ | | | ❸ | | ❹ | | |
|---|---|---|---|---|---|---|---|---|---|
| Bed: 220 | Patient: | SMITH, | JOHN | | | | Date: 18 May 2010 | | CURRENT |
| Time | | 05:30 | 06:00 | 06:30 | 07:00 | 07:30 | 08:00 | 08:30 | 09:00 |
| HR (ECG) | b/min | 70 | 75 | 82 | 67 | 76 | 85 | 72 | 77 |
| ABN | b/min | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RR (RESP) | br/min | 8 | 14 | 9 | 9 | 8 | 8 | 14 | 14 |
| ART/s | mmHg | 165 | 137 | 165 | 165 | 165 | 165 | 137 | 138 |
| MAP | mmHg | 136 | 136 | 136 | 136 | 136 | 136 | 108 | 109 |
| ART/d | mmHg | 108 | 80 | 108 | 108 | 108 | 108 | 80 | 81 |
| ❼ | ❻ | ❺ | | | | | | | |

*Figure 28-2: Tabular trend display*

❶ Bed identification

❷ Patient name

❸ Data collection times

❹ Date of tabular trend

❺ Trended data

❻ Unit of measurement for each parameter

❼ List of parameters

When you select PAGE, the up and down arrow keys move the entire page up or down. When you select SCROLL, the up and down arrow keys move the display up or down one parameter row at a time.

When you select PAGE, the left and right arrow keys move the display to show an entirely new set of columns. When you select SCROLL, the left and right arrow keys move the display left or right by one column.

**To view additional tabular trend parameter data:**

- Select PAGE or SCROLL.
- Use the ↑ and ↓ arrow keys to move parameter rows up or down.

**To view additional data collection times:**

- Select PAGE or SCROLL.
- Use the ← and → arrow keys to move data columns left or right.

# Printing the Trend Display

You can print a copy of the displayed graphic or tabular trend at any time. When using a two-channel printer, the top and bottom halves of the trend display print consecutively.

**To print the trend display:**

- Adjust the trend display as desired.
- Touch PRINT.

# Graphic and Tabular Trend Settings

## Selecting Trend Parameters

The first time you view a patient's graphic trend, the highest priority parameter appears on the bottom trend graph and the next highest priority parameter appears on the top graph. You can view other trends by selecting them from the **Trend Parameter** menu.

**To select a parameter for the top or bottom graph:**

- Select TOP GRAPH or BOTTOM GRAPH.
- Select the desired parameter.

## Selecting a Scale Size

Initially, the system selects a scale that includes all monitored values for the displayed parameter. You can adjust the scale for each parameter using the arrow keys.

**To adjust the scale size:**

- Touch SIZE.
- Select desired parameter key.
- Use the arrow keys to adjust.

## Selecting a Time Base and Expanding the Trend Display

The time base for each trend graph can be set for 2, 6, 12, or 24 hours. The displayed resolution for each time base is:

2 hours = 1 minute

6 hours = 1 minute

12 hours = 2 minutes

24 hours = 4 minutes

You can expand the trend display to include only an hour's worth of information. With EXPAND set to ON, the TIME BASE key is disabled and the trend graph stops updating. When EXPAND is OFF, the trend graph returns to its original display.

**To set a trend graph time base:**

- Touch TIME BASE.
- Select 2, 6, 12, or 24 HRS.

**To expand the trend display:**

- Touch either CURSOR key to move the cursor to the desired location.
- Select EXPAND / ON.

## Setting a Tabular Trends Time Interval

You can display acquired data at the following time intervals: 1, 5, 10, 15, and 30 minutes; and 1, 1.5, and 3 hours. The trend table automatically updates at the end of each time interval, and all data columns shift to the left to include the new interval.

***Note:***

*Updating is suspended when you review data either by paging or scrolling.*

For continuous data, the value displayed in the tabular trend table is the value taken at the displayed time. It is not an average of all readings taken during that time period.

When more than one episodic reading occurs in the same time interval, only the most recent value displays. An asterisk to the right of an episodic value indicates that additional data entries are available for that time interval.

**To set a time interval:**

- Touch TIME INTERVAL.
- Select the desired time interval.

# Trends Troubleshooting Guide

**Caution:**

**Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Current patient data not being added to trends** | ■ If alarms are suspended, data may not be trended at the bedside monitor. | ■ Turn alarms ON or have your system administrator enable your system to trend while alarms are suspended. |
| | ■ ECG or $SpO_2$ processing is suspended. | ■ Resume ECG or $SpO_2$ processing. |
| | ■ EXPAND key is ON (trend data will not be lost). | ■ Set EXPAND key to OFF. Resume ECG or $SpO_2$ processing. |
| | ■ Cursor not in home position (trend data will not be lost). | ■ Move the cursor to the extreme right position. |
| **PCWP trend not available** | ■ PCWP values not saved. | ■ Save the PCWP values. |
| **Incorrect unit of measure displayed** | ■ Incorrect unit of measurement configured for system. | ■ Contact your system administrator. |
| **CALCS data not trending** | ■ Trends does not display Calcs data. | ■ Use the **Calcs** menu to view this data. |
| **NO TRENDS AVAILABLE FOR THIS BED message appears** | ■ No trend data has yet accumulated for the selected parameter. | ■ Allow sufficient time for data to accumulate. |
| **Numerous entries with ??? instead of vital signs** | ■ ALARM SUSPEND key was selected frequently. | ■ Contact your system administrator to collect data during Alarm Suspend periods. |
| | ■ ECG/Resp or $SpO_2$ processing is suspended. | ■ Resume ECG or $SpO_2$ processing. |
| | | ■ Ensure that ECG/Resp amplitude and signal quality are sufficient. |

# Remote Keypad

## Directory of Keys




*Refer to Introduction*










*Refer to Alarms*




*Refer to Printing*







*Refer to Introduction*

**MONITOR SETUP**

PRIVILEGED ACCESS

*Enter clinical password and touch ENTER*

**CLINICAL LEVEL - Select Parameter**

REMOTE KEYPAD STATION ADDRESS

**CLINICAL LEVEL - Set remote keypad station address: X**

| SECURE MODE | | ↑ | ↓ |
|---|---|---|---|
| ON | OFF | | |

# Remote Keypad

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Selecting and Printing a Parameter . . . . . 6
Operating Menu Keys . . . . . 7
Remote Keypad Troubleshooting Guide . . . . . 8

## Overview

The remote keypad is a cordless, hand-held transmitter powered by an internal battery (refer to *Figure 29-1*). It sends your instructions, via infrared signals, to the monitor's receiver, providing all the functions you need to operate your monitor remotely.

The wireless remote control keypad (90360-01) enables you to remotely suspend or adjust alarms, access graphic trends, adjust waveform size, print, etc. The zoom function enlarges menu keys on the monitor, making them easy to read from across the room.

***Note:***

- *The maximum operating range is 20 feet at an angle of up to 45 degrees on either side of the receiver.*
- *The remote keypad cursor remains on the monitor display for approximately one minute following the last keypad activity, or until you touch the touchscreen itself.*

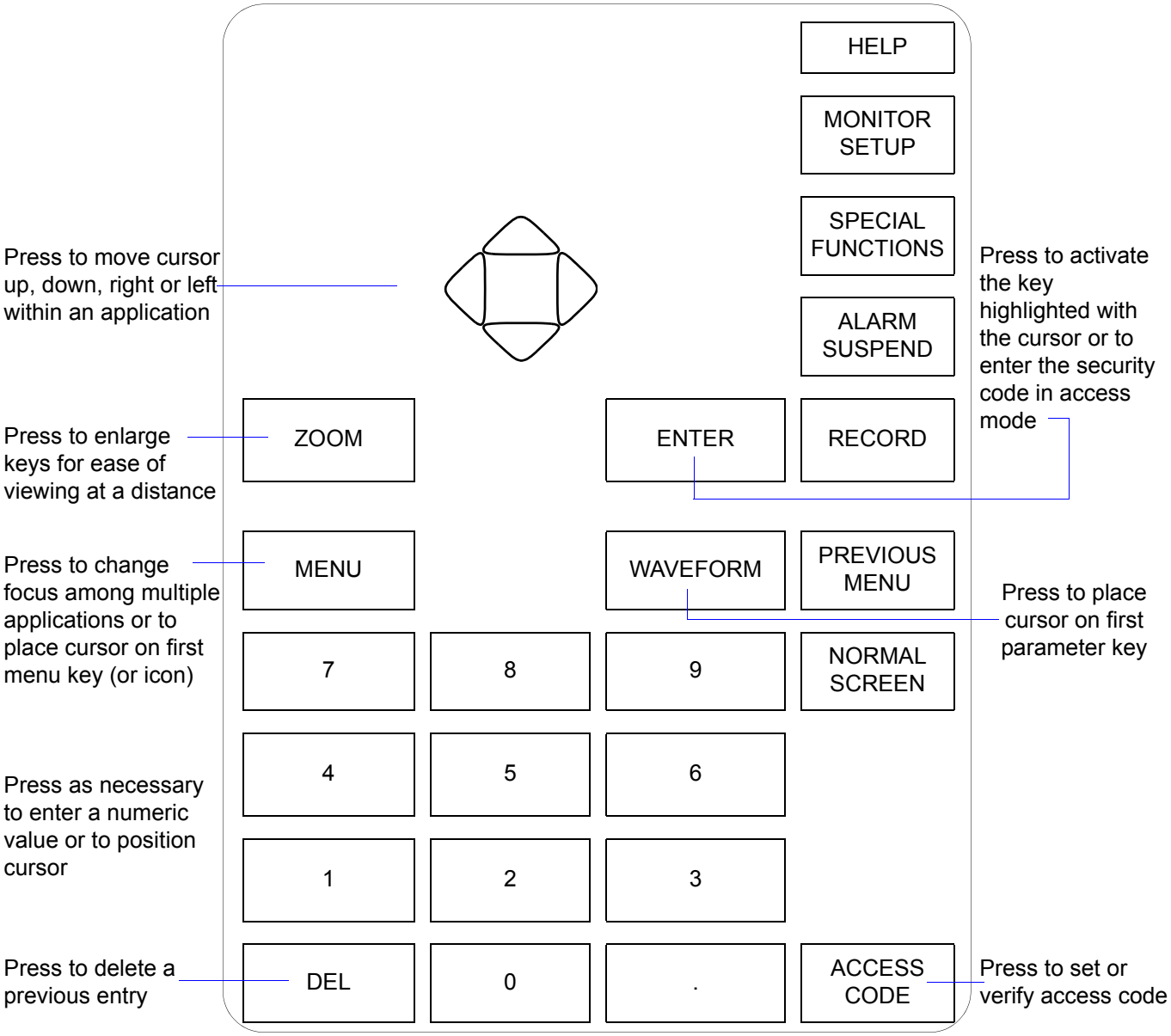



*Figure 29-1: Remote keypad*

# Setting Up the Receiver

The infrared receiver is built into the SL2400/SL2600 monitors. An optional receiver must be connected to the SL2700/SL2800/SL3800 monitors. The receiver attaches to the side of the monitor and connects to the alarm relay output (J3) on the back of the monitor.

## Access Codes

Access codes prevent interference from other remote keypads when monitors are located near each other, by ensuring that the receiver responds only to a remote keypad with a matching code number. If a keypad's access code differs from the receiver's, the command is ignored. The programmed access code (1 to 32) is displayed on the receiver. This code is stored in the monitor's memory and retained whenever the monitor is reset or powered OFF.

Remote keypad systems can also be operated in an UNSECURED mode without access codes, so that the receiver accepts commands from any remote keypad. When in the UNSECURED mode, the word **ALL** appears on the monitor.

When programming a monitor's access code, the keypad's access code must initially match the receiver's. The new access code is programmed simultaneously with the keypad's. The receiver temporarily displays the remote keypad's access code, then returns to displaying its own code.

***Note:***

*To prevent inadvertently changing other access codes, unplug all other monitors (or move the remote keypad directly in front of the monitor to be programmed) and place your finger over the remote keypad's infrared window during programming (sufficient signal transmits through your finger to program the receiver).*

**To select the UNSECURED mode from the monitor display:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch REMOTE KEYPAD STATION ADDRESS.
- Select SECURE MODE / OFF.

**To verify a remote keypad's current access code:**

- Point the remote keypad at the monitor's receiver.
- Touch ACCESS CODE.
- Touch ENTER.

**To set a remote keypad's access code:**

- Point the remote keypad at the monitor’s receiver.
- Touch ACCESS CODE.
- Select the first digit.
- Select the second digit.
- Touch ENTER.

**To set the monitor's access code:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch REMOTE KEYPAD STATION ADDRESS.
- Select SECURE MODE / ON.
- Use the arrow keys to select the number.

# Selecting and Printing a Parameter

The parameter keys display vertically near the right side of the display, with parameter number one at the top. On a split-view central display, parameter number one is at the top of the left column. Press the WAVEFORM key to activate the PARAMETER SELECTION mode.

After you activate the RECORD key, you have two seconds to highlight a parameter key. To ensure enough time in making a selection, place the cursor on the desired parameter key before you press the RECORD key on the remote keypad.

***Note:***

*When printing several parameters at the same time, or when trying to print an event such as a single ectopic beat, it is easier to use the keys on the monitor rather than on the remote keypad to direct the recording.*

**To select a parameter:**

- Point the remote keypad at the monitor's receiver.
- Press WAVEFORM for parameter number 1.
- Press the up or down arrow keys to position the cursor on the desired parameter.
- Press ENTER.

**To print data from a waveform zone:**

- Point the remote keypad at the monitor's receiver.
- Press the up or down arrow keys to position the cursor on the desired parameter.
- Press RECORD.
- Select another parameter, as necessary.
- Press ENTER.

# Operating Menu Keys

The menu keys display horizontally across the bottom of the monitor, with menu key number one at the far left. Press the ZOOM key once to activate the zoom feature, making each key easier to see. Press the ZOOM key again to turn OFF the zoom feature.

**To operate menu keys:**

- Point remote keypad at the monitor's receiver.
- Select a parameter key.
- Press MENU.
- Press the left or right arrow key to the desired position.

# Remote Keypad Troubleshooting Guide

| Clinical Situation | Possible Cause | Solution |
|---|---|---|
| **Monitor accepts commands from any keypad** | ■ Monitor operating in an UNSECURED mode. | ■ Select an access code, and program both the monitor/receiver and the keypad to that code. |
| **During programming, another receiver was inadvertently changed** | ■ Remote keypad placed too close to another monitor's receiver. | ■ Move the keypad directly in front of the receiver to be programmed and place your finger over the keypad infrared window during programming. |
| **Monitor does not respond** | ■ Monitor may not support remote keypad. | ■ Press the ACCESS CODE key. If an **A** does not appear below the NORMAL SCREEN key on the monitor, contact your system administrator or biomedical engineer. |
| | ■ Depleted battery in remote keypad. | ■ Replace battery in remote keypad. |

# Patient Data Logger

## Directory of Keys




*Refer to Introduction*










*Refer to Alarms*




*Refer to Printing*







*Refer to Introduction*

**SPECIAL FUNCTIONS**

| DATA LOGGER |
|---|

**Patient Data Logger**

| PATIENT DATA LOGGER | | SETUP |
|---|---|---|
| ON | OFF | |

**Patient Data Logger - SETUP: Change the settings**

| ALARM LOGGING | | CHECKSUMS | | SAMPLE RATE |
|---|---|---|---|---|
| ON | OFF | ON | OFF | 15 sec |

# Patient Data Logger

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Patient Data Logger Troubleshooting Guide . . . . . 6

## Overview

The Patient Data Logger option automatically sends patient vital signs from the monitor to an external device, such as a printer or a terminal. Episodic patient data is also sampled and transmitted. The output is in the form of ASCII text byte strings, and is printed using standard RS-232 serial communications via the monitor's serial port (refer to *Display Detail* on page 30-4*)*.

This option continues to send data whether the external device is online or offline. Data transmission can be stopped by reassigning the data port or disabling the Patient Data Logger.

Your system administrator (or other designated personnel) must first set up communication between the monitor and the external device by assigning the serial port to Patient Data Logger and then adjusting the serial port settings. The various serial settings can be adjusted to suit the device attached to the serial port. Refer to the appropriate service manual for more details.

**To enable Patient Data Logger:**

- Touch SPECIAL FUNCTIONS.
- Touch DATA LOGGER.
- Select PATIENT DATA LOGGER / ON.

**To set the sample rate:**

- Touch SPECIAL FUNCTIONS.
- Touch DATA LOGGER.
- Touch SETUP.
- Touch SAMPLE RATE until the desired rate appears.

The sample rate refers to the frequency of data sampling and can be set to time intervals ranging from 5 seconds to 60 minutes. The new sample rate takes effect immediately.

# Display Detail

The Patient Data Logger information is automatically sent to an external device, such as a printer or terminal, once the serial port is assigned and toggled ON.

The data fields that appear on this report (ECG, RESP, ART, $SpO_2$, and $EtCO_2$) will vary depending on the parameter modules installed on the system.

**SPACELABS MEDICAL PATIENT DATA LOGGER**

PATIENT NAME DOE, JOHN  Bed # 01  DATE 18 Jul 2011

| | | ECG | | | | | RESP | ART | mmHg | SPO2 | | EtCO2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIME | HR | ABN | LEAD | LEAD2 | ST1 | ST2 | RATE | SYS/DIA | MEAN | % | RESP | % | AGENT | % |
| 14:55:49 | 212 | 0 | VI | II | 2.08 | -2.00 | 52 | 138/81 | 109 | 93 | 0 | 0.1 | HAL | 0.0 |
| 14:55:54 | 158 | 0 | VI | II | 2.08 | -2.00 | 47 | 138/81 | 109 | 95 | 0 | 0.1 | HAL | 0.0 |
| 14:55:59 | 146 | 0 | VI | II | 2.08 | -2.00 | 39 | 138/81 | 110 | 96 | 0 | 0.1 | HAL | 0.0 |
| 14:56:04 | 146 | 0 | VI | II | 2.08 | -2.00 | 36 | 138/81 | 110 | 97 | 0 | 0.1 | HAL | 0.0 |
| 14:56:10 | 212 | 0 | VI | II | 2.08 | -2.00 | 47 | 138/81 | 109 | 97 | 0 | 0.1 | HAL | 0.0 |
| 14:56:15 | 200 | 0 | VI | II | 2.08 | -2.00 | 53 | 138/81 | 110 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:20 | 146 | 0 | VI | II | 2.08 | -2.00 | 43 | 138/81 | 110 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:25 | 146 | 0 | VI | II | 1.84 | -2.56 | 36 | 138/81 | 109 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:30 | 211 | 0 | VI | II | 1.84 | -2.56 | 43 | 138/81 | 110 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:35 | 212 | 0 | VI | II | 1.84 | -2.56 | 53 | 138/81 | 110 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:45 | 146 | 0 | VI | II | 1.84 | -2.56 | 36 | 138/81 | 110 | 97 | 16 | 5.2 | HAL | 0.1 |
| 14:56:52 | 200 | 0 | VI | II | 1.84 | -2.56 | 39 | 138/81 | 109 | 79 | 16 | 5.2 | HAL | 0.1 |

*Figure 30-1: Sample Patient Data Logger report*

The PDL transmits two types of information: page headers and data lines. The page header appears at the top of each page and contains the patient's name, the bed number, and the current date.

**A new page is generated when any of the following situations occur:**

- The end of a page is reached (50 data lines have been transmitted).
- The monitored vital signs parameters change.
- The patient name or bed number changes.
- The current date changes.

Data lines are transmitted at the interval specified at configuration. Each data line contains the time that the data was collected, as well as the data collected for each vital sign parameter being monitored.

Each line of the data printout may contain up to 132 characters and is terminated with line-feed and carriage-return characters.

***Note:***

- *If you are monitoring a large number of parameters and have an 80-column printer, the data from one reading may require more than one line. If your printer has a wrap-around feature, this will be handled automatically. If you prefer that each data reading fits onto one line, condense the printer's type or use a wide-carriage (132 column) printer.*
- *The report prints data from a maximum of 11 parameter groups (for example, ECG, RESP, ART). (Fewer parameters are printed if the line length limit is reached.)*

# Patient Data Logger Troubleshooting Guide

| Clinical Situation | Possible Causes | Solution |
|---|---|---|
| **Data is displayed with improper spacing or double spacing** | ■ The PDL interface sends a carriage return/line feed sequence at each end-of-line. The external device may not be set up properly. | ■ Set the external device for “0” line feed. |
| **No data is displayed or printed on the external device** | ■ There is a power problem or the cables are faulty. The device may not be set up properly. | ■ Check the power and cables. Ensure that the device is in the ONLINE mode and that RS-232 port requirements are satisfied.<br>■ Check for RS-232 compatibility at the monitor and at the external device.<br>■ Check the monitor port assignments and port connections. |
| **Data is lost or garbled** | ■ The cable is faulty.<br>■ The parity is set incorrectly.<br>■ Baud rate settings may be inappropriate. | ■ Check the cables.<br>■ Verify the baud rates and parity settings. |

# Product Specifications

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## Intended Use

The devices documented herein are intended to be used for monitoring of multiple physiological parameters for patients of any age ranging from neonates through adults. In addition to monitoring physiological parameters, these devices also support recording and alarming for those parameters.

The devices documented herein are not therapeutic devices. The devices documented herein are to be used by trained health care professionals in health care facilities. ST segment monitoring is restricted to adult patients only. The devices documented herein are not intended for home use.

**Rx Only** US Federal law restricts the devices documented herein to sale by, or on the order of, a physician.

## Indications for Use

### 91367, 91369, 91370 and 91387 Ultraview Monitors

Spacelabs Healthcare patient monitors, functioning as either bedside or central monitors; passively display data generated by Spacelabs Healthcare parameter modules, Flexports interfaces, and other SDLC based products in the form of waveform and numeric displays, trends and alarms. Key monitored parameters available on the model 91367, 91369, 91370 and 91387, when employing the Spacelabs Command Module, consist of ECG, invasive and noninvasive blood pressure, $SpO_2$, and temperature. Additional parameters and interfaces to other systems are also available depending on the parameter modules employed.

Spacelabs Healthcare patient monitors are intended to alert the user to alarm conditions that are reported by Spacelabs Healthcare parameter modules and/or other physiologic monitors via Flexport interfaces. These devices determine a) when an alarm condition is violated; b) the alarm priority (i.e. high, medium or low); c) alarm limits; and d) when to initiate and terminate alarm notifications. The patient monitors are also capable of displaying alarm conditions on other monitors that are on the network through the Alarm Watch feature.

Spacelabs Healthcare patient monitors may also function as a generic display or computer terminal. As a generic display or terminal, the patient monitors allow network based applications to open windows and display information on other networked monitors.

Spacelabs Healthcare patient monitors are also designed to communicate with a variety of external devices such as displays, network devices, serial devices, user input devices, audio systems, and local/remote recorders.

Spacelabs Healthcare patient monitors are intended for use under the direct supervision of a licensed healthcare practitioner, or by personnel trained in proper use of the equipment in a hospital environment.

## 91496 Command Module

The Spacelabs Multi-parameter Module is intended for use with the Patient Care Management System (PCMS) to acquire, monitor, and process various clinical parameters from an adult or neonate/infant populations in any type of clinical environment other than home use. Physiological parameters that may be monitored include cardiac activity, respiration, invasive and noninvasive pressure, temperature, oxygen saturation ($SpO_2$) and cardiac output. Acquired data may then be communicated to an information network for display, recording, editing and analysis.The devices documented herein are indicated for use by health care professionals whenever there is a need for monitoring of the physiological parameters of patients.

# System Safety Specifications

The monitor's input circuits are designed for use with electrosurgical equipment and defibrillators. Sensors may remain attached to the patient during defibrillation or while an electrosurgical unit is in use, however the readings may be inaccurate during and shortly after use of such equipment. Cardiac pacemakers or other electrical stimulators should not affect or be affected by the operation of this unit.

The *Introduction* on page 1-1 includes information concerning the interconnection of equipment within the Ultraview SL Network. Initial connection of auxiliary, line-operated equipment to a monitor must be performed by a hospital biomedical engineer or a Spacelabs Healthcare Field Service Engineer. For additional information, or instructions regarding interconnection of units, contact a qualified field service engineer or your local Spacelabs Healthcare representative.

After installation and/or interconnection with other units, the equipment leakage current shall not exceed the local (provincial) acceptable values.

Accessory equipment connected to the analog and digital interfaces must be certified according to the respective IEC standards (i.e., IEC 60950 for data processing equipment and IEC 60601-1 for medical equipment). All configurations shall comply with the system standard IEC 60601-1-1+A1. Everyone who connects additional equipment to the signal input part or signal output part is configuring a medical system and is, therefore, responsible for ensuring that the system complies with the requirements of the system standard IEC 60601-1-1+A1 and the electromagnetic compatibility system standard IEC 60601-1-2. If in doubt, consult with a qualified field service engineer.

All Spacelabs Healthcare equipment is intended for use with a fixed mains socket-outlet. If a system is configured using multiple portable socket-outlets, this system must be reviewed for compliance with IEC 60601-1-1+A1, including the maximum load and enclosure leakage currents requirements. The multiple portable socket outlet cannot be placed on the floor. If the leakage current limit is exceeded, a second Protective Earth, fixed at both ends with a tool, may be necessary. This second Protective Earth must be tested to the requirements of clause 18 of IEC 60601-1.

Equipment weighing more than 20 kg is not portable. To lift heavy equipment, support under corners and lift according to hospital procedures.

***Warning:***

***Do not lift the monitor by connected cables or power cords because they might disconnect from the monitor, causing the monitor to drop on the patient.***

Use of patient cables, transducers, sensors, and supplies other than those specified by Spacelabs Healthcare may degrade equipment performance, including defibrillation protection.

Input leakage current for all patient input channels is less than 10 μA, making ECG units suitable for direct cardiac application. The maximum non-destructive voltage that can be applied to any input or output connector on the monitors, modules, or printers is +5 V. All signal inputs or outputs are for exclusive connection to 60601-1 medical equipment, or as specified by Spacelabs Healthcare.

Disposal of these devices and all accessories must be in accordance with local and federal laws.

*Table 1: Products Power Rating*

| Product | Frequency | Electrical Rating | Fuse Rating |
|---|---|---|---|
| 90479-A/B/C | 50/60 Hz | 2 A/115 VAC<br>1 A/230-240 VAC | 2-T2.5 A/250 V (Slow)<br>2-T1.6 A/250 V |
| 90486 | 50/60 Hz | 1.2 A/100-120 VAC<br>0.6 A/220-240 VAC | 2-T1.6 A/250 V<br>2-T1.0 A/250 V |
| 90491/90499/<br>91369/91370/<br>91387/91518 | 50/60 Hz | 100-240 VAC<br>2.0-1.0 A | not user-serviceable |
| 90518 | 50/60 Hz | 100-240 VAC<br>2.0-1.0 A | 2-T1.0A /250 V |

***Warning:***

- ***To protect against electrical shock, proper grounding is essential.***
- ***If the integrity of the external Protective Earth conductor is in doubt, the equipment must be operated from its internal power source (if applicable).***

**Power Cord**

- Three-wire, 18-gauge, hospital grade

  -OR-

- Three-wire, 0.75 $mm^2$, European harmonized

**Plug**

- Three-terminal polarized, with protective ground

***Warning:***

- ***Do not use a 3-to-2 plug adapter.***
- ***Ground terminal of the plug is connected directly to the frame of the instrument. Any interruption of the grounding connector can create an electric shock hazard.***

***Note:***

*All of the products listed in Table 1 include battery backup to ensure that patient information is not lost in the event of a short-term power interruption lasting up to three minutes. Battery powered monitors also provide another layer of electrical security, because they will automatically switch to battery power if main power fails. The integrity of all patient data and the current monitor status is protected as long as the battery charge persists.*

# Equipment Classification

All equipment with patient-applied parts are Type BF or Type CF defibrillator-proof. Refer to *Appendix A — Symbols* on page A-1 for type definitions.

*Table 2: Equipment Classification—Monitors and Housings*

| Model | Classification |
|---|---|
| 91369/91370 | Class I; grounded outlet; internally powered |
| 91387 | Class I; grounded outlet |
| 90491 | Class I; grounded outlet |
| 90499 | Class I; grounded outlet |
| 90479-A/B/C | Class I; grounded outlet |

*Table 3: Equipment Classification—Modules*

| Model | Classification |
|---|---|
| 90341/43/47 | Type BF defibrillator-proof |
| 90449/69 | No patient-applied parts |
| 90478 | No patient-applied parts |
| 90481 | Type CF, cardiac floating |
| 91341/43/47 | Type BF defibrillator-proof |
| 91482 | Type CF defibrillator-proof |
| 91496 | Type BF/CF defibrillator-proof |
| 91517 | Type BF defibrillator-proof |
| 91424/90424 | Type CF, cardiac floating; Hospira optical module provides patient isolation |

*Table 4: Equipment Classification—Other Equipment*

| Model | Classification |
|---|---|
| 90310 | No patient-applied parts |
| 91518 | Class I; grounded outlet<br>Type BF defib proof |

# Equipment Maintenance Requirements

Corrective or maintenance procedures must be performed by qualified personnel.

**Periodic maintenance procedures are required every 12 months to verify the following:**

- Equipment is physically sound.
- Resistance between the chassis ground connector on the rear panel and the protective ground of the mains input is not greater than 0.1 ohm.
- Isolation resistance between ground and mains is greater than 2 meg-ohm.

**While the equipment is operating normally, verify the following:**

- Chassis leakage current is less than 100 μA.
- Patient leakage current is less than 10 μA (Type CF) or 100 μA (Types B and BF).

**While the equipment is operating in single fault condition, verify the following:**

- Chassis leakage current is less than 300 μA (100 to 120 V) or 500 μA (220 to 240 V).
- Patient leakage current is less than 50 μA (Type CF) or 500 μA (Types B and BF).

Under non-optimal environmental conditions or periods of intense use, more frequent checks are recommended.

***Warning:***

- ***Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors which exhibit obvious damage.***
- ***If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.***

# Module Compatibility

**If any function (NIBP, ECG, $SpO_2$, etc.) on your system does not contain a feature described in this manual:**

- Your product may contain an earlier version of software. Contact a qualified service field engineer and refer to the original documentation that accompanied your system.
- Your system configuration may be different from that described in this manual. Refer to notes in this manual describing features where system configuration is likely to impact the available features.

Before moving a module from one network to another, be certain that the module software version is compatible with that required by the second network. If in doubt, have a qualified field service engineer verify compatibility between the module and the network.

# Warnings and Cautions

The following warnings and cautions apply to the system or to multiple system components rather than to specific system components. Warnings and cautions that apply to specific components are located in the chapters describing those components.

## Warnings

### General

- ***Before use, carefully read the instructions, including all warnings and cautions.***
- ***Inspect the monitor, sensor, cables, and connectors before each use. Do not use any equipment that appears damaged.***
- ***Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors which exhibit obvious damage.***
- ***If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.***

- ***Because of the potential for electromagnetic interference, electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) should not be operated within 3.5 feet (1.07 meters) of the patient, patient leads, or associated monitoring equipment until evaluated by the biomedical engineering staff.***
- ***Shock hazards may exist if this instrument is not properly grounded. Protection against electrical shock is provided by grounding the chassis with a three-wire cable and plug. The grounding wire must not be removed or defeated. Grounding reliability can only be assured if connected to a receptacle marked Hospital Only or Hospital Grade.***
- ***To reduce the risk of electric shock, do not remove the protective covers. Only qualified field service engineers should service the instrument.***
- ***There is a risk of explosion if the instrument is operated in the presence of flammable anesthetics or any other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide.***
- ***Always disconnect the instrument from the power supply prior to cleaning.***
- ***Do not operate this instrument if it is wet or if condensation is present. Do not operate this instrument after exposure to extreme moisture, such as direct exposure to rain. If used while wet or when condensation is present, the monitor's performance may be inaccurate, or the monitor or its sensors or sensor cables may fail.***
- ***The use of accessory equipment that does not comply with the monitor's safety requirements may lead to a reduced level of safety. Consideration should be given to the use of the accessory in the vicinity of a patient. The safety certification of the accessory must be performed in accordance with the appropriate IEC 60601-1 and/or IEC 60601-1-1 harmonized national standard.***
- ***EMC compliance may be compromised by the connection of accessory and/or peripheral equipment. Compliance of accessory and/or peripheral equipment must be considered to ensure continued EMC compliance.***
- ***Distorted parameter waveforms and erroneous numerical presentations may be seen if the monitor is exposed to a strong radio-frequency signal. If this occurs, ask a qualified service person to refer to the service manual's EMC appendix to help identify and resolve this electromagnetic interference (EMI).***
- ***Systolic and diastolic pressures displayed numerically for patients being treated with an Intra-Aortic Balloon Pump (IABP) therapy may not be accurate. Display the waveform with scales to verify or determine pressures for these patients.***
- ***Operation outside the specified values may cause inaccurate results.***

## Alarms

- ***Alarm conditions for which you want to be alerted must be set to ON or enabled. You can enable them from the local bedside, remote bedside, or central monitor.***
- ***To protect the patient's safety, do not silence, suspend, or disable audible alarms without providing continuous, direct observation of the patient.***
- ***Disabling alarm tones at a monitor eliminates alarm tones for all alarm conditions at that monitor, even in the case of life-threatening events.***

## Electrodes, Lead Wires, Sensors, and Sensor Cables

- ***Carefully route all cables between the patient and the monitor to reduce the possibility of patient entanglement or strangulation.***
- ***Signals resulting from devices such as Implantable Cardiac Defibrillators (ICD) may momentarily blank the ECG waveform rather than display an out-of-range signal. In such cases it may not be apparent that the ICD has triggered and the condition of the patient should be checked. In all instances of the ICD being triggered, the monitor will redisplay the ECG waveform within five seconds.***
- ***ECG alarms for ventricular fibrillation and asystole remain active while the patient's rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, ventricular run, couplet, VE/minute, atrial fibrillation, pause, and PSVT are not reactivated until the learning process ends.***
- ***Use only monitoring cables and safety lead wires to protect against accidental connection to electrical power cords or outlets. Failure to do so may result in adverse health consequences or death.***
- ***To ensure against any possibility of electric shock, do not touch lead electrodes or the monitor during defibrillation.***

## Defibrillators, Pacemakers, and Electrosurgical Activity

- ***ECG detection circuitry may continue to count the pacing rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon ECG rate alarms. Keep patients with pacemakers under close surveillance.***
- ***The system may insert pacemaker flags into the ECG signal in response to signals that are not pacemaker pulses. Therefore, if you use a Spacelabs Healthcare monitor to observe pacemaker performance, you must take into account all possible sources of pacemaker flags.***
- ***Use the pacemaker manufacturer's performance analyzer as the primary means of evaluating pacemaker operation.***
- ***Some rate adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate value). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.***

- ***While pacemakers are being programmed, the programming device may suppress the ECG waveform, preventing QRS detection and rate counting. This may result in an erroneous asystole alarm.***
- ***Keep the monitor and its power cord and cables away from the electrosurgery unit and its associated cables and power cord.***
- ***During electrosurgical activity, the system may not accurately detect pacemaker activity because of the electrical interference.***
- ***Signals resulting from devices such as Implantable Cardiac Defibrillators (ICD) may momentarily blank the ECG waveform rather than display an out-of-range signal. In such cases it may not be apparent that the ICD has triggered, and the condition of the patient should be checked. In all instances of the ICD being triggered, the monitor will redisplay the ECG waveform within five seconds.***

## Cautions

### General

- **Disposal of these devices and all accessories must be in accordance with local and federal laws.**
- **Detach all connectors and cables by grasping the connectors and pulling them straight out. Do not detach connectors and cables by pulling on the cables themselves.**
- **Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.**

### Electrodes and Lead Wires

- **Visually inspect each lead wire for obvious damage and replace as needed.**
- **Use only patient cables and lead wires specified by Spacelabs Healthcare. Other cables and lead wires may degrade performance and may damage the monitor during defibrillation or high-frequency electrosurgery. Non-Spacelabs Healthcare cables and lead wires may also change the required input impedance and DC offset voltage, affecting monitor performance.**
- **Do not use stainless steel electrodes.**
- **Place the electrodes as far away from the electrosurgery site as possible, because significant high-frequency currents may flow into the electrodes. This can cause patient burns, especially if a defect is present in the neutral cable or return pad of the electrosurgical unit. Placing electrodes too close to the electrosurgery site can also result in noisy waveforms.**
- **Do not allow conductive parts of electrode leads or connectors, including the neutral electrode, to contact other conductive parts, including the ground.**

# Battery Use, Maintenance, and Disposal

## Contents

Overview . . . . . 1
Nickel Metal Hydride Batteries . . . . . 1
SL2700/SL2800/SL3800 Monitors . . . . . 2
SL2400/SL2600 Monitors . . . . . 2
90518 Multigas Analyzer . . . . . 3
Digital Telemetry . . . . . 3

## Overview

Spacelabs Healthcare products are equipped with a variety of battery types and technologies to meet the demands of powering critical circuits and portable equipment. This section briefly describes the products and types of batteries required for proper operation. Additionally, suggestions are provided for charging practices to optimize battery performance and disposal after the battery no longer functions within the manufacturer's specifications.

***Warning:***

***Batteries exposed to short circuit, high temperature, or fire may leak, vent, or explode.***

**Caution:**

**Follow the manufacturer's recommended handling procedure. Collect and transport batteries in a manner that prevents short circuit, compacting, mutilation, or any other abuse that would compromise the physical integrity.**

***Note:***

- *Used batteries must be properly disposed of or recycled according to national and/or local regulation.*
- *Refer to the product service manual for more details.*

## Nickel Metal Hydride Batteries

Nickel metal hydride (NiMH) batteries should be fully charged and discharged at least three times before use to ensure maximum run time. No other maintenance is required for NiMH batteries.

***Note:***

*Used batteries must be properly disposed of or recycled according to national and/or local regulation.*

# SL2700/SL2800/SL3800 Monitors

The SL2700/SL2800/SL3800 monitors use NiMH batteries to provide a short-term charge reservoir during a power interruption. The monitor will cease to function during a power interruption. However, the monitor retains the patient data for at least three minutes during an AC mains power interruption.

***Note:***

*Replace the batteries every year. Refer to the appropriate service manual for instructions.*

# SL2400/SL2600 Monitors

Sealed lead-acid (SLA) or NiMH batteries can be used in the SL2400/SL2600 monitors. Refer to *Figure 32-1* to install one or two batteries.



*Figure 32-1: Monitor battery installation*

**Batteries can be exchanged, without a loss of patient data, under the following conditions:**

- The unit is being powered by an external power supply; or
- The unit is operating on batteries (provided one charged battery remains connected at all times during the exchange).

Batteries can also be exchanged when the unit is powered OFF. However, powering OFF the monitor will result in a loss of patient data.

A green battery LED on the front panel flashes when that battery is being charged. The green battery LED is continually illuminated when the charging cycle is complete, if connected to AC power.

***Note:***

- *A faulty battery will cause that battery's green LED to flash intermittently. Replace the faulty battery with the same battery type.*
- *Only a charging cycle or a faulty battery causes a green battery LED to flash. These conditions only occur when a battery is installed in the monitor.*
- *The solid green power LED does not indicate the battery charge level.*

# 90518 Multigas Analyzer

The 90518 multigas analyzer contains two SLA batteries to provide short-term operation during a power failure. The analyzer retains the operating configuration for up to five minutes during an AC mains power interruption.

***Note:***

*Replace the batteries every year. Refer to the appropriate service manual for instructions.*

# Digital Telemetry

Digital telemetry transmitters use a single, 9-volt, alkaline or lithium battery.

***Note:***

- *No maintenance is required for single-use, 9-volt, alkaline or lithium batteries.*
- *Used batteries must be properly disposed of or recycled according to national and/or local regulation.*

The 90479-A digital telemetry housing is equipped with an internal, rechargeable, SLA battery assembly. A battery-charging unit is built into the telemetry housing and charges automatically when the housing is connected to the AC mains power. An external battery-charging accessory is not needed for this device.

The housing and eight modules retain the operating configuration for up to ten minutes during an AC mains power interruption.

# Cleaning, Disinfecting, and Sterilization

## Contents

Monitors, Modules, Cables, and Printers . . . . . 1
Cleaning Products Not Recommended for Use . . . . . 2
Accessories . . . . . 3
TruLink Noninvasive Blood Pressure Cuffs . . . . . 3

## Monitors, Modules, Cables, and Printers

### Cleaning/Disinfecting

***Warning:***

- ***Use only recommended cleaning solutions, or you may void the manufacturer's warranty.***
- ***Harsh chemical agents degrade plastics and will compromise the safety of the device. Some germicidal and other harsh cleaning compounds are known to damage some plastics by weakening the structural integrity and compromising the electrical insulating properties.***
- ***Disconnect the equipment from the patient and the electrical supply before cleaning.***
- ***Do not allow liquid to enter the interior of the module or monitoring equipment.***
- ***Do not immerse the equipment or cables in water or cleaning solutions.***
- ***Do not autoclave.***

**Caution:**

**Use caution when cleaning cable connectors so that liquid is not permitted to collect around the electrical contacts or seep inside the connector. Trapped liquids and surface residues provide an unintentional electrical path, which may cause noisy signals and false alarms.**

**To clean the exterior of monitors, modules, and cables:**

- Prepare the cleaning solution according to the manufacturer's instructions.
- Wet a clean cloth with the selected cleaning solution.
- Remove excess liquid from the cloth and squeeze dry.
- Wipe exposed surfaces of the equipment and cables.
- Remove any soap residue by gently wiping with a clean damp cloth.
- Wipe dry with a clean dry cloth.

***Note:***

*After cleaning ECG lead wires, remove the ECG lead wires from the lead block and thoroughly dry them at the lead block ends and at the lead connector ends. Thorough drying will prevent residual moisture from providing a low-current path between leads, which can interfere with lead off detection and cause false asystoles.*

**Use only the following recommended cleaning solutions:**

- Mild soap and water solution
- U.S. Pharmacopoeia (USP) green soap
- Sodium hypochlorite solution (1:10 dilution of household chlorine bleach in water)
- Phenolic germicidal detergent (1% aqueous solution)
- Glutaraldehyde (2.4%) (Cidex)
- Isopropyl alcohol (70% solution)

***Note:***

*Over time, repeated use of a chlorine bleach solution may cause some colors to fade.*

Tape adhesive can be removed with Spacelabs Healthcare adhesive tape remover pads (P/N 392196-001).

**Caution:**

**Questions and concerns about cleaning issues should be directed to a Spacelabs Healthcare field service engineer.**

## Touchscreen Cleaning

Clean the touchscreen with a soft cloth moistened with either 70% isopropyl alcohol solution or soapy water.

***Note:***

- *Follow your hospital protocol for the handling of blood and body fluids.*
- *Do not allow liquid to enter the monitor.*

# Cleaning Products Not Recommended for Use

***Warning:***

***Accelerated Hydrogen Peroxide (AHP) and quaternary ammonia-based products ARE NOT RECOMMENDED for cleaning monitors and cables. These chemicals attack the plastics used in patient monitors and cables, and will cause serious safety hazards as the electrical insulating properties and structural integrity of the equipment break down.***

***Cavicide, Virex, Virex 256, SaniCloth, and Sanicloth Plus are common quaternary ammonia germicidal products. The manufacturers of these solutions advertise that these germicidal products are safe for use on hard, non-porous surfaces, such as linoleum floors, formica countertops, and stainless steel. The manufacturers discourage the use of quaternary ammonia germicidal products on computer-grade plastics and on data, patient, and power cables, which are classified as porous materials.***

# Accessories

- Where provided, follow the manufacturers' instructions concerning disposable and reusable supplies.
- As applicable, follow your hospital protocol concerning cleaning, disinfection, and/or sterilization of reusable supplies.
- Follow local hospital protocols to dispose of used and contaminated single-use accessories.

Use of patient cables, transducers, sensors, or supplies other than those specified by Spacelabs Healthcare may adversely affect monitor performance.

# TruLink Noninvasive Blood Pressure Cuffs

## TruLink Reusable and Disposable Cuffs

The disposable cuff wrap is designed for single patient use. It is packaged non-sterile and cannot be soaked, rinsed, or sterilized.

The reusable cuff is packaged non-sterile. It may be cleaned and disinfected with an enzymatic detergent and 10% solution of household bleach (5.25% sodium hypochlorite).




*Figure 33-1: TruLink reusable and disposable cuffs*

## Cuff Cleaning and Disinfection

### Materials

- Enzymatic detergent such as ENZOL (US) or CEDEZYME (UK)

- 10% solution of household bleach (5.25% sodium hypochlorite) in distilled water
- Soft cloths or bristle brushes
- Spray bottles

### Procedure

1 Prepare the enzymatic detergent and bleach solutions in separate bottles according to the manufacturer's instructions.

2 Spray detergent liberally on cuff, allowing it to sit for one minute.

3 Remove detergent with a soft cloth. For persistent contamination, scrub with a soft bristled brush.

4 Rinse the cuff thoroughly with distilled water.

5 Spray bleach solution on the affected area until saturated. Allow the cuff to sit for five minutes.

6 Remove any excess solution with a soft cloth and rinse again with distilled water. Allow two hours for air drying at ambient temperature.

***Note:***

*Make sure water does not enter the hose connector.*

## ABP Cuffs

Refer to the *90207/90217 Ambulatory Blood Pressure Monitors, Operations Manual* (P/N 070-0137-xx) for cleaning instructions related to ABP cuffs and monitor.

# Diagnostic Messages

| Message | Action |
|---|---|
| *Unable to support a new module at this time* | Insufficient memory to support a new module.<br>Unplug modules to free memory. |
| *Unable to support a new channel at this time* | Insufficient memory to support a new channel.<br>Detach channels to free memory. |
| *Diagnostic error encountered loading module* | Checksum error detected loading module.<br>Restart the monitor. |
| *Diagnostic error encountered loading channel* | |
| *Out of memory — deleting hemo entry* | Insufficient memory available to the application to complete the requested operation. |
| *Out of memory — deleting resp entry* | |
| *Out of memory — deleting oxy entry* | |
| *Out of memory — deleting renal entry* | |
| *Remote monitor not responding* | Calcs timeout expired waiting for remote GDS response.<br>Verify that the remote monitor is on the network and try again. |
| *Error reading data* | Bad return code from GDS on data read; GDS is possibly corrupt.<br>Reboot the monitor. |
| *Error storing data* | |
| *Error deleting stored data* | |
| *No trend data available* | There is no trend data in GDS. |
| *No other bed on the network has active parameters* | This message is in response to a remote request. The monitor has determined that there are no beds on the network with active parameters; remote operations are not possible at this time. |
| *There are no parameters active on this bed* | The selected bed has no active parameters. |
| *Parameter is not available to monitor* | Failed attempt to attach to a channel. |
| *Maximum number of parameters exceeded* | Insufficient memory to support a new parameter. |
| *Communications with remote monitor interrupted* | Lost connection to the remote monitor.<br>Verify that the remote monitor is on the network and retry remote operation. |

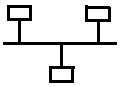
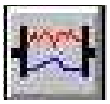
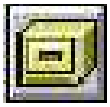
| Message | Action |
|---|---|
| *This insertion will cause prior assignment to be lost* | The requested zone assignment will cause a previously assigned zone to be lost.<br>Touch PREVIOUS MENU or NORMAL SCREEN to abort the operation. |
| *Remote bed select feature is in use by another application* | Remote Bed Select is in use by another application. Only one application may use this feature at one time.<br>Touch the application using the Remote Bed Select feature, and then touch PREVIOUS MENU or NORMAL SCREEN to abort the selection. The feature will now be available for use. |
| *Unable to record the requested alarm channel(s)* | Unable to perform the requested operation.<br>Verify that a recorder is selected and operational. |
| *Unable to record the requested channel(s)* | |

# Appendix A — Symbols

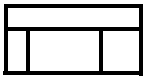
The following list of international and safety symbols describes all symbols used on Spacelabs Healthcare products. No one product contains every symbol.

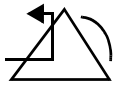
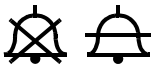
**Note:** Graphic elements of certain keys and symbols may vary between product lines.

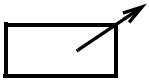
| | |
|---|---|
|    | HELP Key |
| ? | HELP (Explain Prior Screen) Key |
|   | MONITOR SETUP Key |
|  | REMOTE Key |
|   | TRENDS Key |
|   | RECORD Key |
|  | Dynamic Network Access (DNA) Key |
|   | SPECIAL FUNCTIONS Key |
|   | NORMAL SCREEN Key |

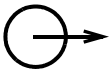
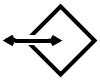
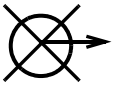
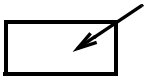
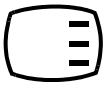
| | |
|---|---|
|   | SAVE Key |
|  | No Network Connection |
|  | Network Connection |
|  | Do Not Connect to Network |
|  | No Connection to Intesys® Clinical Suite (ICS) |
|  | Compression |
|  | Magnifying Glass |
|  | File Cabinet |
|   | List of Rooms |
|  | Printer |
|  | Service Message |
|   | PREVIOUS MENU Key |
|  | HOME Key |
|  | Arrows |

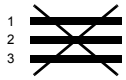
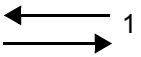
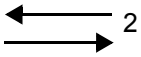
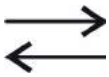
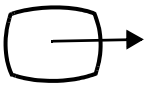
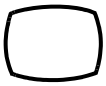
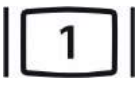
# Appendix A — Symbols

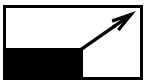
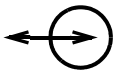
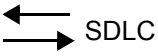
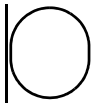
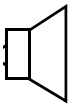
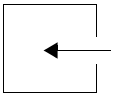
| | |
|---|---|
|  | On Direction |
|  | ON — Power Connection to Mains |
|  | ON — Part of the Instrument Only |
|  | ON Position for Push Button Power Switch |
|  | OFF — Power Disconnection from Mains |
|  | OFF Position for Push Button Power Switch |
|  | OFF — Part of the Instrument Only |
|  | Partial ON/OFF |
|  | ON/OFF |
|  | Standby |
|  | STANDBY Key<br>Power ON/OFF Key |
|  | Keyboard Connection |
|  | Mouse Connection |
|  | PAUSE or INTERRUPT |
|  | START/STOP Key |

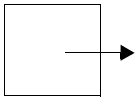
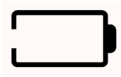
| | |
|---|---|
|  | START/STOP |
|  | STOP or CANCEL Key |
|  | CONTINUE Key |
|  | ENTER Key |
|  | Delete |
|  | Nurse Alert Interface |
|  | ALARM SUSPEND/TONE RESET Key |
|  | ALARMS Key |
|  | Alarm, General |
|  | Alarm Reset |
|  | Alarm Audio ON |
|  | Alarm Audio OFF |
|  | Alarm Audio Paused |
|  | Low Priority Alarm |
|  | Medium Priority Alarm |

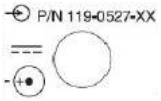
| | |
|---|---|
|  | High Priority Alarm |
|  | Alarms Paused |
|  | Alarm OFF |
| --- | Parameter below measurement range |
| +++ | Parameter above measurement range |
| ??? | Parameter measurement indeterminate |
|  | Indicator — Remote Control |
|  | PRINT REPORT Key |
|  | Normal Screen |
|  | Clock/Time Setting Key |
|  | Slow Run |
|  | Activate Recorder for Graphics |
|  | Reset |
|  | START (NIBP) Key |

| | |
|---|---|
|  | Power Indicator LED |
|  | Activate Telemetry Recorder |
|  | Output (Non-terminated) |
|  | Data Input/Output |
|  | Input |
|  | No Output (Terminated) |
|  | Indicator — Local Control |
|  | Indicator — Out of Paper |
|  | Recorder Paper |
|  | Menu Keys |
|  | Waveform/Parameter Keys |
|  | Return to Prior Menu |
|  | Monitor Setup<br>Select Program Options |
|  | Set Initial Conditions Menu |

| | |
|---|---|
|   | Access Special Function Menu |
|   | Return Unit to Monitor Mode |
|  | Keypad |
|   | Serial Port 1 |
|   | Serial Port 2 |
|  | Serial Port |
|  | Auto Mode (NIBP) |
|  | External Marker Push Button Connection |
|  | Arterial Pulse |
|  | Gas Exhaust |
|  | Video Output |
|  | Television; Video Display |
|   | Video Output, Primary |
|   | Video Output, Secondary |

| | |
|---|---|
|  | Enlarge, Zoom |
|  | Input/Output |
|  | PCMCIA Card |
|  | Touchscreen, External |
|  | Universal Serial Bus |
|   | SDLC Port |
|  | Hard Drive |
|  | Antenna |
|  | Electrocardiograph or<br>Defibrillator Synchronization |
|  | Microphone |
|  | Foot Switch |
|  | Audio Output, Speaker |
|  | Event |
|  | Gas Sampling Port |

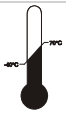
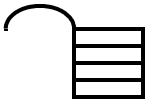
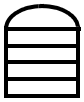
| | |
|---|---|
|  | Gas Return Port |
|  | Battery<br>Replace only with the appropriate battery. |
|  | Battery Status |
|  | Battery<br>Replace only with the appropriate battery. |
|  | Low Battery |
|  | Replace only with the appropriate battery.<br>(+ / - signs may be reversed) |
|  | All batteries should be disposed of properly to protect the environment. Lithium batteries should be fully discharged before disposal. Batteries such as lead-acid (Pb) and nickel-cadmium (Ni-Cd) must be recycled. Please follow your internal procedures and or local (provincial) laws regarding disposal or recycling. |
|  | This symbol indicates that the waste of electrical and electronic equipment *must not* be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment. |
|  | Caution - hazardous voltages. To reduce risk of electric shock, do not remove the cover or back. Refer servicing to a qualified field service engineer (U.S.A.).<br>DANGER - High Voltage (International) |
|  | Protective Earth Ground |
|  | Replace Fuse Only as Marked |
|  | Power supply jack polarity.<br>(+ / - signs may be reversed) |
|  | Alternating Current |
|  | Both Direct and Alternating Current |

| | |
|---|---|
|  | Functional Earth Ground |
|  | Fuse |
|  | Equipotentiality Terminal |
|  | Direct Current |
|   | Input Power. Use only Spacelabs Power Supply (P/N 119-0527-xx). |
|  | AC/DC Input |
|  | Loop Filter |
|  | Audio Output, Speaker |
|  | IEC 60601-1 Type B equipment. The unit displaying this symbol contains an adequate degree of protection against electric shock. |
|  | IEC 60601-1 Type BF equipment which is defibrillator-proof. The unit displaying this symbol is an F-type isolated (floating) patient-applied part which contains an adequate degree of protection against electric shock, and is defibrillator-proof. |
|  | IEC 60601-1 Type BF equipment. The unit displaying this symbol is an F-type isolated (floating) patient-applied part providing an adequate degree of protection against electric shock. |
|  | IEC 60601-1 Type CF equipment. The unit displaying this symbol is an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock, and is defibrillator-proof. |
|  | IEC 60601-1 Type CF equipment. The unit displaying this symbol is an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock. |
|  | IEC 60601-1 Class II equipment, double-isolated. The unit displaying this symbol does not require a grounded outlet. |

| | |
|---|---|
|  | Caution - Consult Accompanying Documents |
|  | Follow Instructions For Use |
|  | Operates on Non-Harmonized Radio Frequencies in Europe |
|  | Adult Noninvasive Blood Pressure (NIBP) |
|  | Fetal Monitor Connection (Analog) |
|  | Fetal Monitor Connection<br>RS-232 (Digital) |
|  | Physiological Monitor Connection RS-232 (Digital) |
|  | Noninvasive Blood Pressure (NIBP), Neonate |
|  | Symbol Set, Adult/Pediatric Cuff Sizes |
|  | Symbol Set, Neonatal Cuff Sizes |
|  | NIBP Cuff, Neonatal 1 |
|  | NIBP Cuff, Neonatal 2 |
|  | NIBP Cuff, Neonatal 3 |

| | |
|---|---|
|  | NIBP Cuff, Neonatal 4 |
|  | NIBP Cuff, Neonatal 5 |
|  | NIBP Cuff, Single Hose |
|  | NIBP Cuff, Dual Hose |
| THIS SIDE TO PATIENT | NIBP Cuff, Surface Applied to Patient |
| CHILD | NIBP Cuff, Child Size<br>(12 to 19 cm) |
| CHILD, LONG | NIBP Cuff, Child Size, Long<br>(12 to 19 cm) |
| SMALL ADULT, LONG | NIBP Cuff, Small Adult Size, Long<br>(17 to 25 cm) |
| SMALL ADULT | NIBP Cuff, Small Adult Size<br>(17 to 25 cm) |
| ADULT, LONG | NIBP Cuff, Adult Size, Long<br>(23 to 33 cm) |
| LARGE ADULT, LONG | NIBP Cuff, Large Adult Size, Long<br>(31 to 40 cm) |
| LARGE ADULT | NIBP Cuff, Large Adult Size<br>(31 to 40 cm) |
| ADULT | NIBP Cuff, Adult Size<br>(23 to 33 cm) |
| INFANT | NIBP Cuff, Infant Size<br>(8 to 13 cm) |

| | |
|---|---|
| NEONATAL 1 | NIBP Cuff, Neonatal 1 Size (3 to 6 cm) |
| NEONATAL 2 | NIBP Cuff, Neonatal 2 Size (4 to 8 cm) |
| NEONATAL 3 | NIBP Cuff, Neonatal 3 Size (6 to 11 cm) |
| NEONATAL 4 | NIBP Cuff, Neonatal 4 Size (7 to 13 cm) |
| NEONATAL 5 | NIBP Cuff, Neonatal 5 Size (8 to 15 cm) |
| THIGH | NIBP Cuff, Thigh Size (38-50 cm) |
| NYLON | NIBP Cuff, Nylon Material |
| SOFT | NIBP Cuff, Soft Material |
| VINYL | NIBP Cuff, Vinyl Material |
| QTY | Quantity |
| ARTERY | Place Artery Symbol and Arrow over Brachial or Femoral Artery |
|  | Consult Instructions For Use |
| **Warning** | Warning About Potential Danger to Human Beings |
| **Caution** | Caution About Potential Danger to a Device |

| | |
|---|---|
| **Note** | Note |
|  | Keep Dry |
|  | Indoor Use Only |
|   | Environmental Shipping/Storage Altitude Limitations |
|  | Environmental Shipping/Storage Temperature Limitations |
|  | Fragile; Handle with Care |
|  | This Way Up |
|  | Up Arrow |
|  | Down Arrow |
|   | Environmental Shipping/Storage Humidity Limitations |
|  | Open Padlock |
|  | Closed Padlock |
|  | Happy Face |
|  | Sad Face |

| | |
|---|---|
|   | PVC-Free (Polyvinyl Chloride) |
|   | Do Not Reuse; Single Use Only |
|  | Reusable |
|   | Drip-Proof |
|   | Reference Number or<br>Order Number |
|  | Recycle |
|   | Non Sterile |
|   | Latex-Free |
|  | Date of Manufacture |
|  | Radio transmitting device; elevated levels of non-ionizing radiation |
|  | A CE mark certifies that a product has met EU health, safety, and environmental requirements, which ensure consumer safety. |
|   | XXXX is the European Notified Body number. 0123 is the number for TÜV SÜD Product Service GmbH, München, Germany. |
|  | Canadian Standards Association Approved |

| | |
|---|---|
| LOT | Batch Code |
| NE 2 | Nellcor Oxisensor II Compatible |
| NV X | Novametrix Compatible |
| TruLink® | Spacelabs TruLink Compatible |
| OxiMax | Nellcor OxiMax Compatible |
| | Spacelabs Compatible |
| c UL us | UL recognized component in Canada and United States |
| Nellcor OxiMax works here | Nellcor OxiMax Compatible |
| Masimo SET | Masimo SET Compatible |

**Abbreviations used as symbols are shown below.**

| | |
|---|---|
| **1 - 32** | Access Codes 1 Through 32 |
| **AIR** | Air |
| A | Amperes |
| **ANT 1**<br>**ANT 2** | Diversity Antenna System 1<br>Diversity Antenna System 2 |
| **Arr1**<br>**ArrNet2** | Arrhythmia Net 1<br>Arrhythmia Net 2 |
| **$avDO_2$** | Arterial/Venous Oxygen Difference |
| **$CaO_2$** | Arterial Oxygen |

| | |
|---|---|
| **CH**<br>**ch** | EEG, EMG, or ECG Channel<br>EEG Channels - CH1, CH2, CH3, CH4<br>EMG Channel - CH5 |
| **cm$H_2O$** | Centimeters of Water |
| **C.O.**<br>**CO** | Cardiac Output |
| **$CvO_2$** | Venous Oxygen |
| **CO2**<br>**$CO_2$** | Carbon Dioxide |
| **DIA**<br>**dia** | Diastolic |
| **ECG**<br>**ecg** | Electrocardiogram |
| **EEG**<br>**eeg** | Electroencephalogram |
| **EMG**<br>**emg** | Electromyogram |
| **ESIS** | Electrosurgical Interference Suppression |
| **EXT** | External |
| **FECG** | Fetal Electrocardiogram |
| **FHR1**<br>**FHR2** | Fetal Heart Rate, Channel 1<br>Fetal Heart Rate, Channel 2 |
| **GND**<br>**gnd** | Ground |
| Hz | Hertz |
| **Hgb** | Hemoglobin |
| **HLO**<br>**hlo** | High-Level Output |
| **Multiview** | Multi-Lead Electrocardiogram |
| **$N_2O$** | Nitrous Oxide |
| **NIBP**<br>**nibp** | Noninvasive Blood Pressure |
| **$O_2AV$** | Oxygen Availability |
| **$O_2$** | Oxygen |

| | |
|---|---|
| **$PaO_2$** | Partial Pressure of Arterial Oxygen |
| **PRESS**<br>**press**<br>**PRS** | Pressure |
| **$PvO_2$** | Partial Pressure of Mixed Venous Oxygen |
| Ref. | Oxygen reference gas port |
| **RESP**<br>**resp** | Respiration |
| **SDLC** | Synchronous Data Link Control |
| **SPO2**<br>**SpO2**<br>**$SpO_2$**<br>**$SaO_2$** | Arterial Oxygen Saturation<br>as Measured by Pulse Oximetry |
| **SVO2**<br>**$S\underline{v}O2$**<br>**$SvO_2$** | Mixed Venous Oxygen Saturation |
| **SYS**<br>**sys** | Systolic |
| **T1**<br>**T2**<br>**T3**<br>**T4** | Temperature 1<br>Temperature 2<br>Temperature 3<br>Temperature 4 |
| **TEMP**<br>**temp** | Temperature |
| **UA** | Uterine Activity or Umbilical Artery |
| **UV** | Umbilical Venous |
| **VAC** | Vacuum Connection |
| **$VO_2$** | Oxygen Consumption |
| V | Volts |
| W | Watts |

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